

cycles



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It is with deep regret that we announce the death of Daniel Trembly MacDougall, botanist, author, and a member of the Committee of the Foundation for the Study of Cycles.

Dr. MacDougall was born March 16, 1865 in Liberty, Indiana; obtained his doctorate at Purdue in 1891. He served with the U. S. Department of

Agriculture, University of Minnesota, New York Botanical Gardens and finally with the Carnegie Institution of Washington where he was Director of Botanical Research and the Laboratory of Plant Physiology from 1905 to 1933. He was the author of many books and the recipient of many honors.

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THE DIRECTOR'S LETTER

Dear Member:

A recent analysis of our renewals shows that those members who join for two years have a one-half *better* renewal rate than those who join for only one year.

This could mean, of course, that the two-year boys, as we call them, knew better what they were about than the one-year boys, but I doubt it. I think it means that it takes about two years for a person to learn how to make use of a knowledge of cycles. The concepts are new. Even the terminology may be strange. However, for those people who stay with it for awhile, the renewal rate is very high.

Our Foundation

It always pleases me when, in letters from members, they refer to *our* foundation. It is your Foundation. You support it! Your ideas, as they are passed on by letter or by word of mouth, influence its policies.

In the very near future we hope to give you an even more direct voice in the management of Foundation affairs. It is proposed to elect chapter presidents to the governing board of the Foundation.

Social Physics

Professor John Q. Stewart of Princeton has noticed that human activity obeys certain laws that can be set down in ways similar to the way in which the laws governing the be-

havior of matter are set down. The study of these laws he calls *Social Physics*.

The tendency of people to congregate in cities is one example. To be specific, it has been found that the second largest city in a cultural area tends to be half as big as the largest city; the third largest city tends to be a third as big; and so on.

The same thing often holds true of the size of the companies in an industry. If the largest chain store, or canning company, or steel company is three or four or five times as large as its next biggest competitor, there may be restraint of trade. However, if it is merely *twice* as large, that is *normal*, our anti-trust law do-gooders to the contrary notwithstanding. (How I hate them!)

Human activity also displays what the physicists call *inertia*. This is the tendency of a body at rest to remain at rest; of a body in motion to remain in motion. We often think of this latter aspect as momentum. This law of inertia helps us to understand the law of growth. When some form of human activity, such as steel production, is increasing at a certain rate—for example, doubling every ten years—it tends to continue to increase at that rate. Or at least it does until another law, which we might liken to *friction*, steps in and slows down the rate of advance.

When we understand these laws of human behavior we are able to make very dependable forecasts. We can tell, many years in advance,

the levels to which our population, our economy, even our company, will have grown.

I often read of the grand and glorious things we can do, vis-a-vis the Russians for example, "if we want to." Of course we can! But will we *want to*? A knowledge of these laws of growth and inertia and momentum tell us—not that we can't—but that, in all probability we won't! The elements and factors that have made things as they are are still with us. They are not likely to give way except under great pressure.

This is not a defeatist attitude. Let us strive for improvement with might and main. But, as forecasters, let us not be too optimistic about radical change overnight, in anything.

There is another law that governs human activity. It controls the variation from normal. Things may get out of line in one direction, but they don't stay out of line in that direction. A correction sets in and then they get out of line in the opposite direction. Some people call this *the law of action and reaction*. It is interesting to note that things rarely get out of line very much. They almost always get pulled back to normal before they stray too far.

Cycles

Insofar as it deals with human activity, the study of cycles is a subdivision of social physics. Its counterpart in physics is *vibration*—the tendency of certain things (for example a violin string), to oscillate to and fro *rhythmically*, i.e. at uniform time intervals; with a beat.

It is quite amazing that human activity—along with plant and animal activity—should behave this way. However, it does. No one knows why. Maybe it is the nature of human beings to act so. Maybe there are rhythmic forces in our environment that influence us and cause us to behave so. But whatever the cause, the *result* is that we can get light on the probable future course of almost every aspect of human behavior—days, months, even years in advance.

Sunspots and Business

Back in 1878 a British economist named Jevons advanced the theory that sunspots caused "commercial crises." As I told you in some detail last year (*Cycles*, January 1957, pages

13 & 14), Jevons' theory was in part based on the observations of Dr. Hyde Clarke. Clarke, in 1838, wrote of an 11-year cycle in speculation and famine. This 11-year cycle has continued for the 120 years since its discovery.

In 1934 two Harvard research workers, Carlos Garcia-Mata and Felix Shaffner, set out to prove that Jevons was all wrong. They got a research grant to show that there was *no* relationship between business, stock prices, etc. and sunspots.

Presently, however, Garcia-Mata and Shaffner found that there *was* a relationship. However, it was not the relationship that Jevons had imagined. Jevons thought that variation in the number of sunspots produced corresponding variation in crops and that through this means we had variation in business. Garcia-Mata and Shaffner found that crops did *not* behave this way, but that business itself, stock prices, etc. did. In other words, that the effect was not through crops, but was direct through human beings!

The paper that Garcia-Mata and Shaffner wrote to report their findings is so important that we are devoting the greater part of this issue to a reprint of it.

Also, we are conducting research to bring Garcia-Mata and Shaffner's work up to date. We plan to give you a report of our work later this year.

It will interest you to know that Dr. Garcia-Mata is very active in the New York Chapter of the Foundation. I suspect that Dr. Shaffner will be equally active in the Washington Chapter as soon as it gets going.

There is, I think, no question but that there is a cycle a little over 11 years long in sunspots and a cycle a little over 11 years long in business, manufacturing, stock prices, etc. Two questions remain unanswered: One, are these one and the same cycle? And two, if so, are sunspots the *cause* of the terrestrial cycle, or are *both* sunspots and human beings affected by some more basic cyclic force. In time, the Foundation hopes to answer both of these questions.

Cordially yours,

Edward R. Dew

Director

Research by Staff

WHAT'S AHEAD FOR OATS PRICES?

BY G. SHIRK

The average monthly price of oats has been sliding gradually downward since the end of 1956. It has not been a perfectly smooth course--the individual months bounce around some--but if the variations are smoothed into a general trend, that trend has been down.

The actual price is diagrammed on Figure 1 by means of a solid line, and the down trend since 1956 is apparent. The series used in this study was for No. 3 white oats at Chicago. The period included in the complete analysis was from January, 1923, through May, 1958, by months.

The odds are that the downward course in the actual price is about over, and that, *ideally*, oats prices will reach a low about August of this year.

The broken line on Figure 1 below shows the combination of the 12-month (seasonal) cycle, the 26.64-month cycle, and a trend. It is this combination which reaches a low at August.

All other factors, including other cycles

which affect the price of oats are ignored.

The Seasonal Pattern

Figure 2 on the next page shows the 12-month cycle together with the data on which it is based. The solid line A gives the deviations from a 13-month moving average. The average yearly pattern is computed from these figures. This pattern is the broken line B. This 12-month cycle, showing the month as a percentage of the yearly trend, follows:

Jan	106.2%	July	95.7%
Feb.	103.5	Aug	92.0
Mar	102.6	Sep	95.3
Apr	102.3	Oct	96.8
May	101.6	Nov	100.9
Jun	99.5	Dec	104.5

These figures represent an average relationship. That is, the figure for January is the average of the percentage that the actual monthly prices have been of the yearly trend

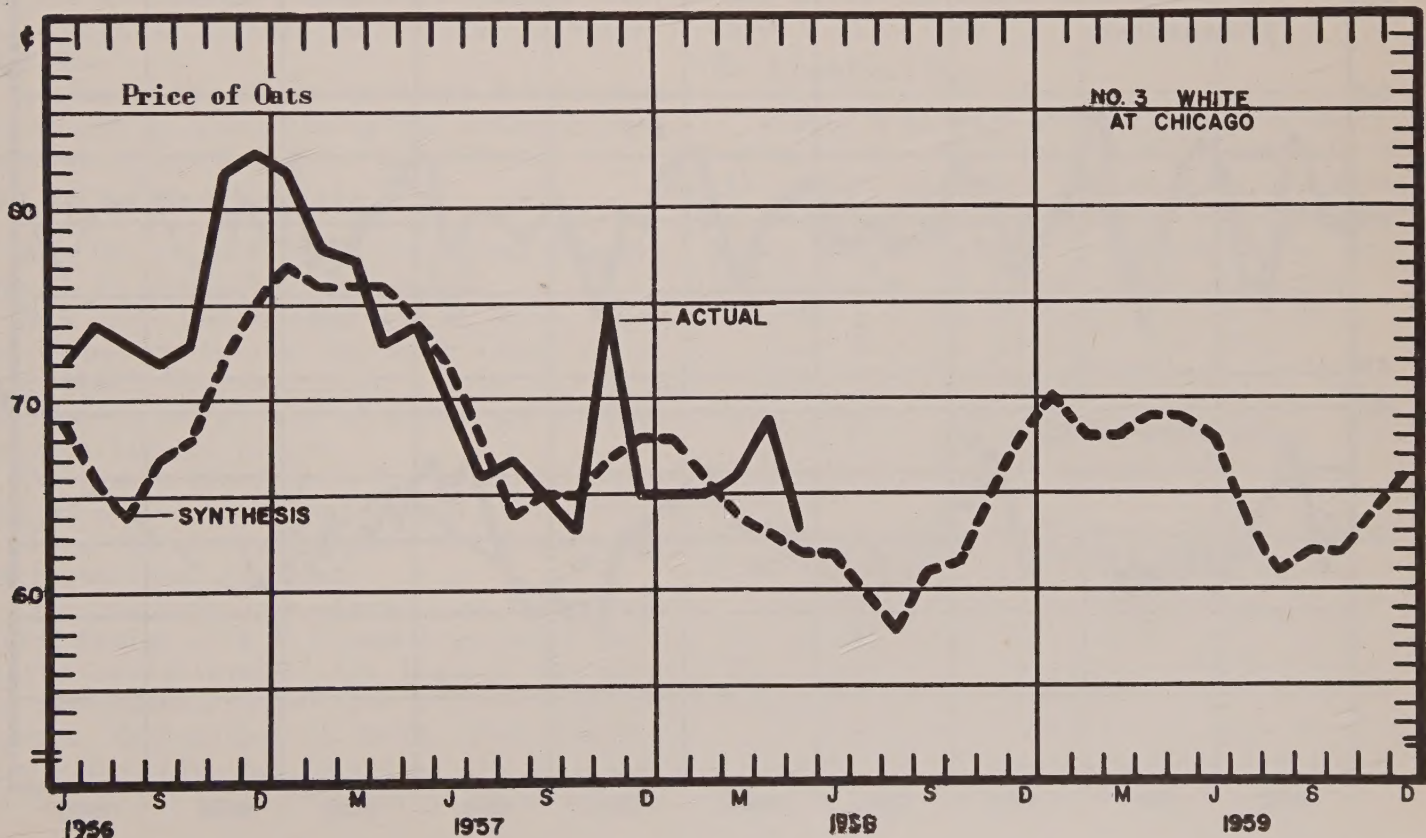


Fig. 1 The Price of Oats. Actual Prices vs the Combination of Cycles and Trend.

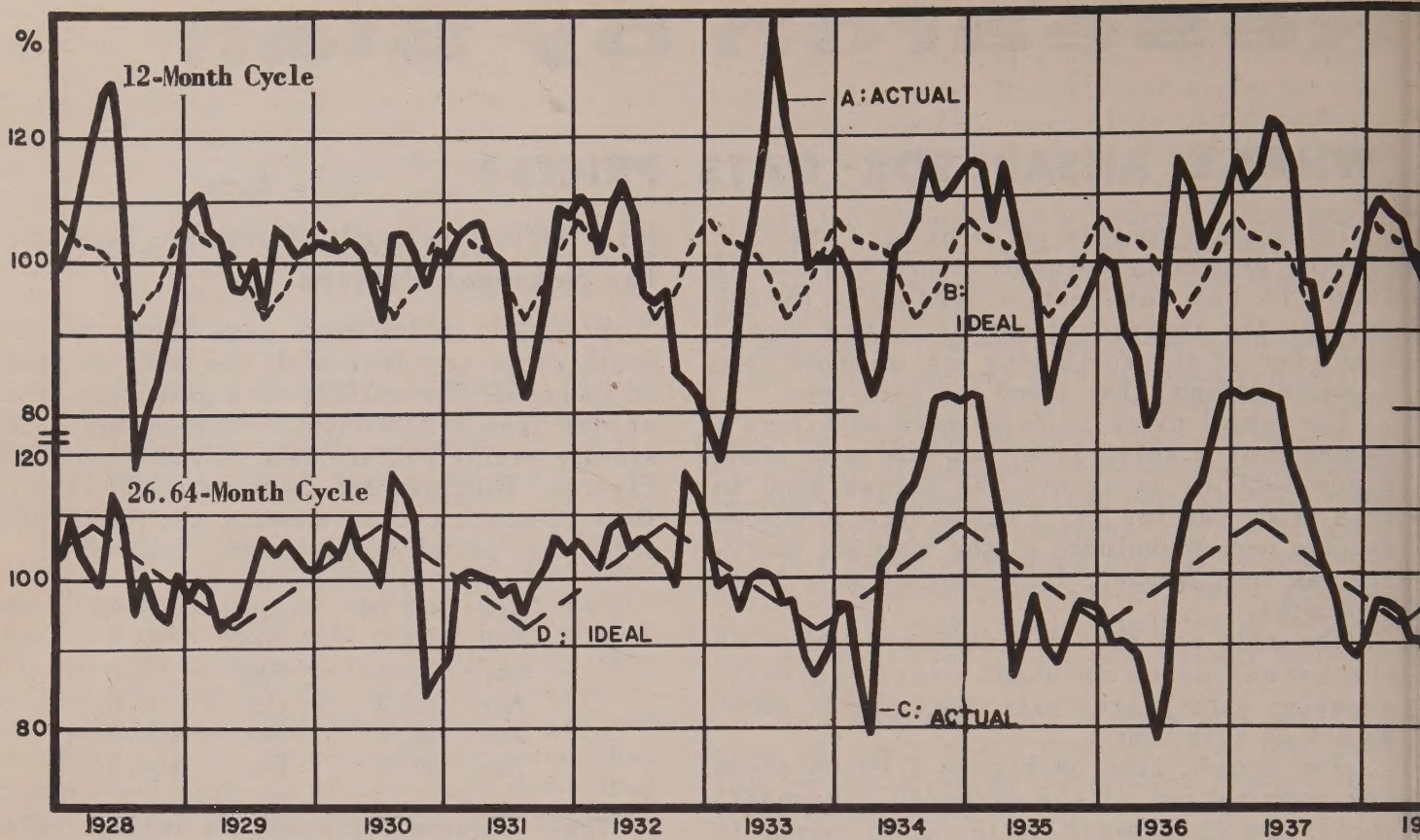


Fig. 2 The Price of Oats. The Actual and Ideal 12-Month and 26.64-Month Cycles.

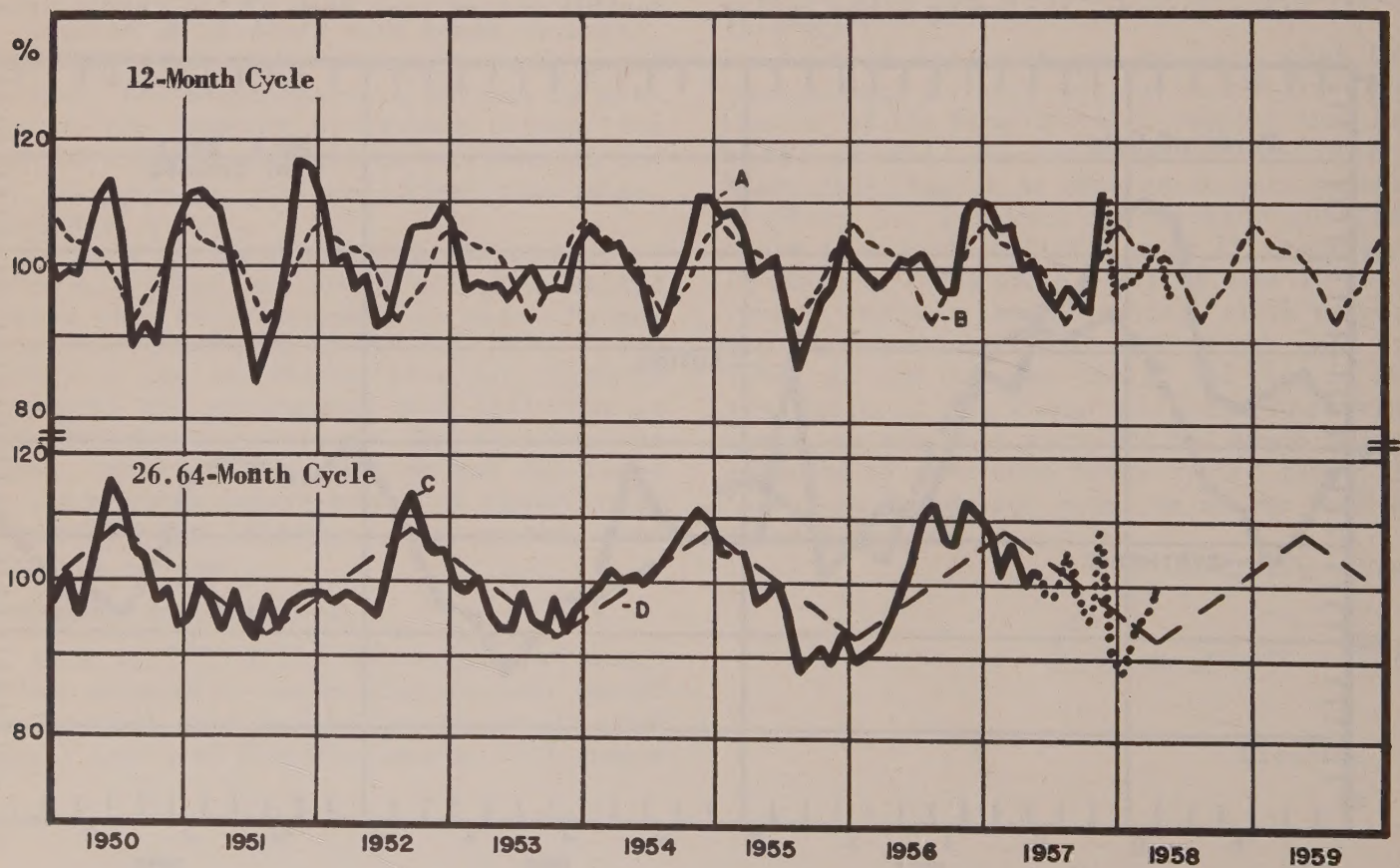
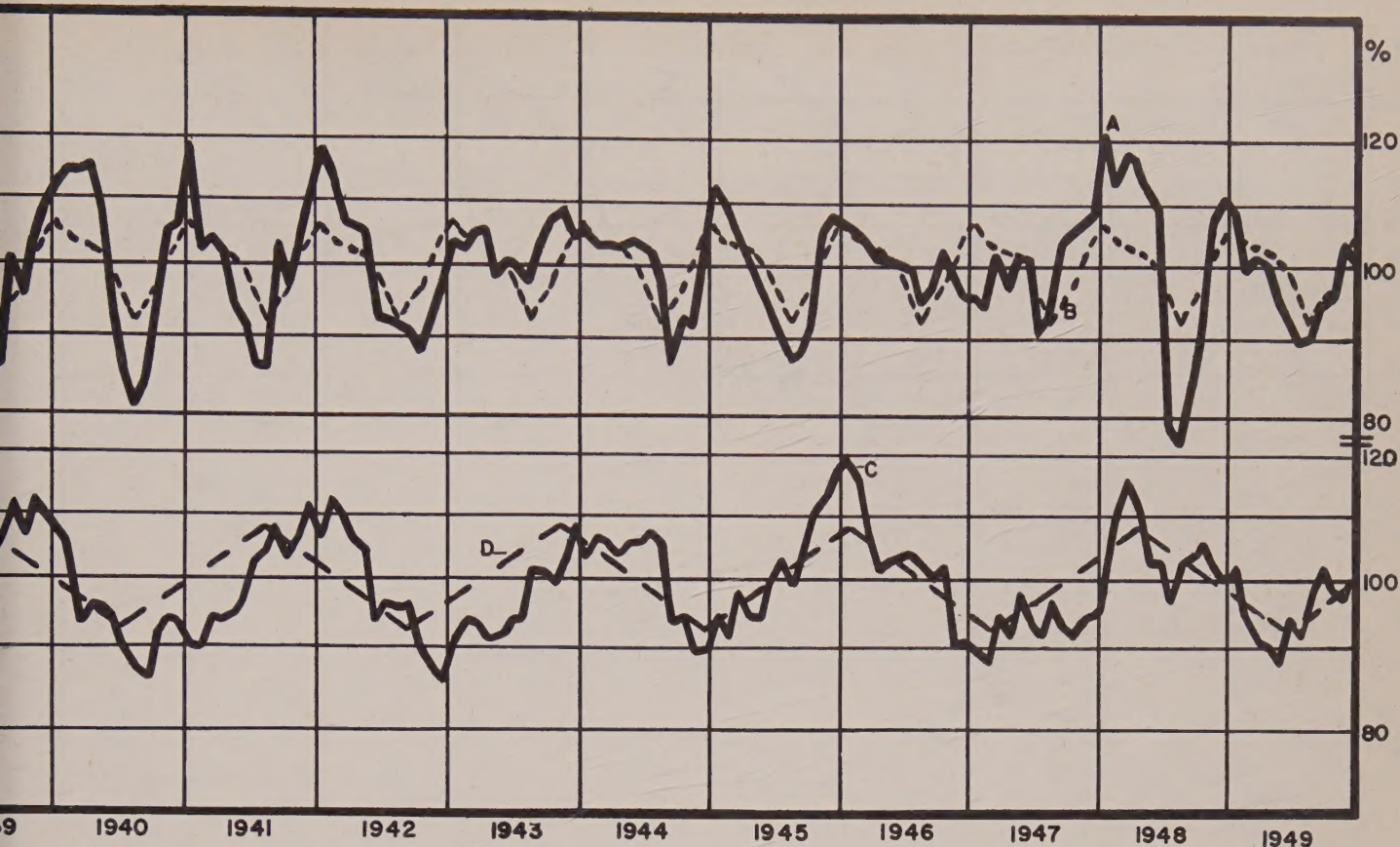


Fig. 2 Continued



for all the Januarys from 1923 through 1958. These figures express the typical relation, 1923-58.

A comparison of Curves A and B will show the extent to which the *actual* seasonal pattern has followed the *average* pattern.

The 26.64-Month Cycle

When the seasonal cycle is removed from the data, a 26.64-month cycle emerges.

This cycle had an ideal low at April, 1958, and is now on the way up to an ideal top at May, 1959. The amplitude of the cycle is 107.9% of trend at time of crest, and 92.7% of trend at time of trough.

The broken line, Curve D, on Figure 2 is a diagram of the ideal 26.64-month cycle. Curve C shows the actual cycle, the figures on which the ideal is based.

(For the technician—Curve C is a 3-section moving median of a 26.64-month periodic table of the deviations of the logs of the data (ex the 12-month cycle) from a 25-month moving average. Beginning with March, 1955, Curve C is not smoothed, but is rather the record of the deviations before smoothing. An extrapola-

tion of the 25-month moving average brings Curve C up to date.)

The Combination

Figure 3 on page 220 outlines the combination of the three factors which are used in the current synthesis. The chart is a diagram to show the progressive effect of adding the parts, and includes a comparison of the combination with the actual prices since 1950.

Curve A is the 26.64-month cycle alone.

Curve B is the seasonal cycle alone.

Curve C is the combined 12-month and 26.64-month cycles.

Curve D is the trend currently being used.

Curve E adds the trend to the combined cycles.

The bottom portion of the chart repeats Curve E and compares it to actual prices.

The variation in the past between the actual and the combination lines is a measure of the dominance of the two cycles we have so far isolated in this series.

Any variation in the future will also be a measure of the extent to which the cycles dominate the price of oats.

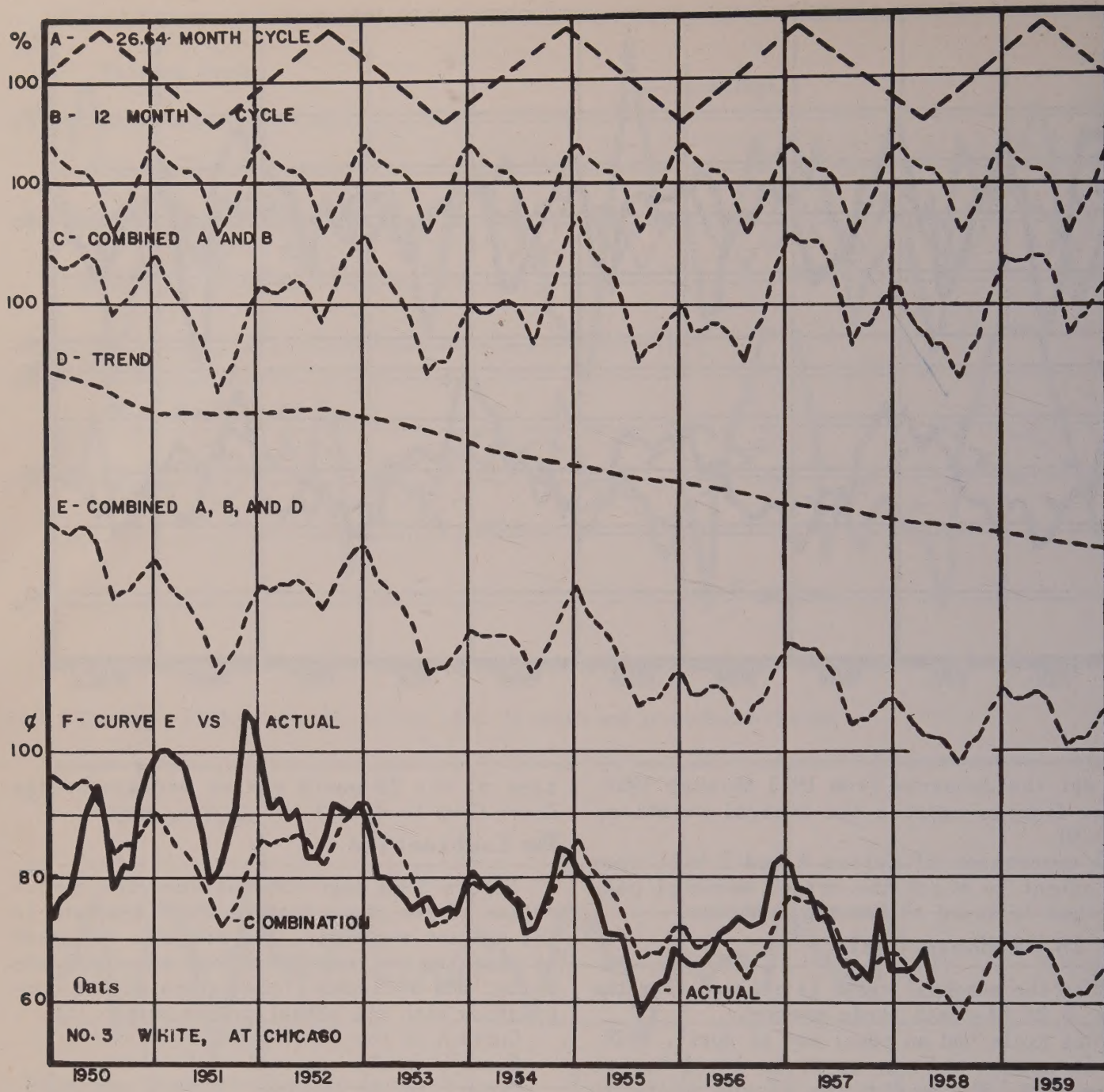


Fig. 3 The Price of Oats. The Progressive Combination of Cycles and Trend and Actual Prices.

SOLAR AND ECONOMIC RELATIONSHIPS

A PRELIMINARY REPORT

By

Carlos Garcia-Mata

and

Felix I. Shaffner

Reprinted from

The Quarterly Journal of Economics

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FOREWORD

Carlos Garcia-Mata and Felix Shaffner started out to prove, once and for all, that there is no shadow of evidence of any relation between sunspots and business activity. They came out with—this.

Thanks are due to them and to The Quarterly Journal of Economics for permission to reprint.

The notion of solar influence in human affairs will not die. Is it because there is something to it? Or is it because of its romance? I do not know.

Doctors Garcia-Mata and Shaffner, whose study of the subject is the most dispassionate and objective of which I know, would be the first to say we need more facts.

This report was written in 1934.

The Foundation for the Study of Cycles is now in the process of bringing it up to date. We plan to publish the result of our investigations as soon as possible.

Because of space limitations some editing of the original article was necessary, but this was done with care, so as not to alter the line of thought.

One point is clear. Whatever the cause, the ups and downs of many human affairs come too regularly to be easily the result of chance. In consequence, this regularity cannot be ignored. It gives us the probabilities of the future. It gives us a valuable tool for forecasting.

Edward R. Dewey

July 28, 1958

FOUNDATION FOR THE STUDY OF CYCLES

SOLAR AND ECONOMIC RELATIONSHIPS

BY CARLOS GARCIA-MATA AND FELIX SHAFFNER¹

This paper is an outgrowth of an attempt to establish a factual basis for the orthodox viewpoint on Jevons' hypothesis concerning business cycles and sunspots. As the investigation progressed, it was found necessary to widen its scope; and the results, while in one way they confirm the orthodox viewpoint, indicate that the last word on the general subject has not yet been said. The present article is to be considered as a provisional report only.

Result of Work

For more than half a century orthodox economists preferred to treat the Jevonian hypothesis more as an intellectual speculation than as a scientific theory. Tho the theory has recently gained so much attention that economists have not been able to ignore it completely, it was not difficult to prove that the supposed close relation between the solar cycle and agricultural fluctuations did not in fact exist. But when the analysis was extended to economic phenomena other than agricultural fluctuations, the evidence disclosed a resemblance between the solar cycle and business activity so close as to command serious consideration. Indeed, this evidence was so striking that we thought it necessary to conduct further investigations to prove the resemblance accidental. In this we were unsuccessful, and therefore we were obliged to seek in the literature of solar-terrestrial relations all the available material which could be used to sustain the hypothesis of some direct connection between them. This material is submitted herewith.

As is well known by all students of the subject, Jevons' hypothesis was that the variations in the number of sunspots produced corresponding variations in crops and that through this channel business cycles were brought about. Working on the assumption that the sunspot cycle had an established length of 11.11 years, he tried to find a periodicity of similar length in agricultural prices. His failure to do so is now well known and was recognized at the time even by him.

There are several reasons for Jevons' lack of success. First of all, he lacked the statistical tools necessary to treat time series. Furthermore, altho the solar cycle has been detected clearly in several terrestrial phenomena, . . . it can be seen only by averaging the local variations, which for a given locality are very much more important than

the solar cycle. Taking the world as a whole, the solar cycle appears clearly,² but it would be difficult to detect it in the British Isles, where Jevons' data were collected.

Jevons' Method

In his investigations, Jevons went as far back as 1701, twenty years before the South Sea Bubble, and after a detailed search in old records he found evidence of unbroken periodicity of the more or less decennial crises. Counting the crises between the "unquestionable collapses" of 1721 and 1867, he obtained an average of 10.43 years between them.³ Using other starting points, he found similar periods, and remarked on the striking coincidence between that figure and the average of 10.45 years which he sought to assign to the sunspot cycle. But he could "see no reason why the human mind, in its own spontaneous action, should select a period of just 10.44 years to vary in. . . ." Some outside phenomenon related to the solar cycle, he continued, was timing the industrial waves so as to make them fall in line with one solar period.

Jevons, tho unsuccessful, was truly ahead of his time. He regretted that the astrophysicists were depending on a value of the solar "constant" made by Pouillet in 1837, instead of making daily measurements to find out if the "constant" varied.⁴ The astrophysicists did not suspect such variability until the measurements of Langley in 1903; and only after 1919 were daily records kept by the Smithsonian Institution—records which allowed Dr. C. G. Abbot to prove the true variability of the so-called solar "constant" of radiation.⁵

The solar hypothesis of business cycles thus remains today more or less in the same status that it was in 1882, at the time of Jevons' death. But other theories are commonly cited in textbooks in connection with the Jevonian hypothesis.

Moore's Theory

The first of these is Professor H. L. Moore's theory.⁶ It is founded on his discovery of an 8-

2. THO MIXED WITH THE EFFECT OF OTHER WORLDWIDE TERRESTRIAL PHENOMENA.

3. JEVONS, W. S., INVESTIGATIONS IN CURRENCY AND FINANCE, P. 215 (THE PAPER ON "THE PERIODICITY OF COMMERCIAL CRISES AND ITS PHYSICAL EXPLANATION.")

4. OP. CIT., P. 234, ALTHO JEVONS WAS THE ONLY ECONOMIST TO EXPOUND A WELL-ROUNDED THEORY OF THE CONNECTION BETWEEN SOLAR AND BUSINESS FLUCTUATIONS. HIS STUDIES WERE IN PART ANTICIPATED BY SIR WILLIAM HERSCHEL IN 1801.

5. "ANNALS OF THE ASTROPHYSICAL OBSERVATORY OF THE SMITHSONIAN INSTITUTION," WASHINGTON, 1932, VOL. V, P. 2. THE PRESENT INVESTIGATION OWES MUCH, AT VARIOUS POINTS, TO THE PIONEERING WORK OF DR. ABBOT.

6. HENRY L. MOORE: ECONOMIC CYCLES, THEIR LAW AND CAUSE, NEW YORK, 1914; AND GENERATING ECONOMIC CYCLES, NEW YORK, 1923.

1. THE INVESTIGATION WAS MADE WITH THE AID OF TWO GRANTS FROM THE COMMITTEE ON RESEARCH IN THE SOCIAL SCIENCES OF HARVARD UNIVERSITY. WE ARE INDEBTED TO MR. EDGAR LAWRENCE SMITH OF NEW YORK CITY FOR FRIENDLY ENCOURAGEMENT AND WISE COUNSEL. DR. M. J. FIELDS OF HARVARD ALSO RENDERED VALUABLE ASSISTANCE.

DR. MATA IS RESPONSIBLE FOR THE IDEA UPON WHICH THE INVESTIGATION IS BASED, FOR THE BULK OF THE RESEARCH, THE CHARTS AND THE REPORT OF THE COMMITTEE. DR. SHAFFNER COLLABORATED IN OUTLINING THE ORIGINAL PROJECT AND IN THE PREPARATION OF THIS PAPER, WHICH IS BASED ON THE REPORT.

year cycle in rainfall in the United States from 1881 to 1921, correlated with identical cycles discovered previously in much longer records of rainfall in the Ohio Valley, corroborated by a somewhat similar cycle in English wholesale prices. Moore's theory is that "a known natural cause originates an agricultural cycle which in turn generates other economic cycles," the natural cause being the lapse of 8 years between the return to "the maximum approach to a straight line" in the periodic conjunctions of the earth and Venus with the sun.⁷

Persons' Conclusion

Without entering into the debatable merits of the harmonic analysis employed by Professor Moore, we merely note that one of the most important links in Moore's reasoning is his transition from agricultural prices to general business series. Concerning this, we may quote the conclusions of Dr. Warren M. Persons, the result of a careful statistical study. "We have found, then, that the production and prices of agricultural commodities do not exhibit cyclical or wave-like movements such as appear in the changes of general business conditions and of the general commodity price level, but rather show oscillatory year-to-year fluctuations." Furthermore, there are many logical reasons for denying the relation, at least in the large industrial countries.

The assumption is that the solar influence is felt in the variation of the yields. But Dr. W. M. Persons has demonstrated that while there is extremely high correlation (+.92) between yields and physical production of crops in the United States, the correlation between physical production and total values is almost nil (-.04).⁸ Hence the argument that the variation of yields affects the purchasing power of the farmer is not true, for the simple reason that the law of supply and demand takes care of that. Perhaps in agricultural countries in which prices are regulated by the world market (for example, Australia or Argentina) it would be possible to maintain that a high yield in the year's crops can bring prosperity to the whole country. The American farmer knows well, however, that bumper crops sometimes bring prices so low that all the earning margin is gone.⁹

Huntington's Theory

Much more interesting from our point of view

7. *IBID.*, p. 97.

8. W. M. PERSONS, *FORECASTING BUSINESS CYCLES*, NEW YORK, 1931, p. 193.

9. JEVONS' SON HAS LATELY PUBLISHED AN ARTICLE RE-STATING THE WHOLE THEORY, IN THE JOURNAL OF THE ROYAL STATISTICAL SOCIETY, VOL. XCVI, PART IV, 1933, p. 545. IN THIS HE QUOTES AN ARTICLE PUBLISHED IN 1917 IN THE INDIAN JOURNAL OF ECONOMICS, IN WHICH A LIST OF CRISES SINCE 1670 IS RECORDED WITH A FREQUENCY DISTRIBUTION WHICH LOOKS SIMILAR TO THE "SUNSPOT CYCLE"; BUT THE SAME ARGUMENTS ABOUT THE IMPORTANCE OF CROPS IN ECONOMIC LIFE ARE REPEATED, WITHOUT NEW PROOFS OF THE EXISTENCE OF THE SOLAR CYCLE IN CROP DATA. THEREFORE THE THEORY REMAINS IN THE SAME SITUATION AS BEFORE. THIS NEW ARTICLE OF JEVONS' SON, HOWEVER, ADMITS AND STRESSES THE NECESSITY OF MORE RESEARCH IN THE FIELD.

in the research on Jevons' theory is Professor Ellsworth Huntington's theory, because of its new approach in the search for the "missing link" between solar variation and business fluctuations. He thinks that the relation is an indirect one, operating through an influence of solar radiation on health and of health on business. "Business cycles," he writes, "appear to depend largely on the mental attitude of the community; and the mental attitude depends on health."¹

That business cycles depend on mental attitude can be accepted; but Huntington's proof that the mental attitude depends upon health is not convincing, because he based his statistical correlation on various lags. He found the following:²

- 1 year between health and mental power
- 1 year between health and school attendance
- 3 years between health and New York bank clearings
- 4 years between health and general business
- 4 years between health and national bank deposits
- 5 years between health and immigration

As Sorokin has said of Huntington's theory, "The use of elastic 'lags,' which shorten and lengthen according to the requirements of the problem, can make correlations where none exist."³ Since Huntington uses death rates *inverted* as a health index (a procedure in itself open to discussion),⁴ it is possible through adequate lags to prove statistically the reverse, i.e. that bank deposits, immigration and business *precede* death rates.

Summary

Summing up, we may state:

First, the fact of a correlation between the solar cycle series and a business cycle series has not yet been established.

Second, the logical reason for a connection has not been found. There is still a "missing link," as Jevons said . . .

During the period of more than fifty years since the original investigation of Jevons, astronomical knowledge of solar radiation has advanced enormously.⁵ Hale, in 1908 discovered that sunspots form magnetic fields, and the fact that they shoot electrons to the earth prepared the way for a more logical explanation of the relation between solar and terrestrial phenomena.

New Data

In 1919 the Smithsonian Institution began to keep daily records of the amount of solar energy

1. E. HUNTINGTON, *WORLD-POWER AND EVOLUTION*, NEW HAVEN, 1920, p. 29.

2. *OP. CIT.*, p. 36.

3. P. SOROKIN, *CONTEMPORARY SOCIOLOGICAL THEORIES*, NEW YORK, 1928, p. 127.

4. SOROKIN, *IBID.*, p. 140.

5. ALL THE FACTS ABOUT SOLAR ASTROPHYSICS QUOTED IN THIS PAPER, EXCEPT THOSE SPECIFICALLY ACKNOWLEDGED, HAVE BEEN TAKEN FROM THE AUTHORITATIVE SOURCE, *HANDBUCH DER ASTROPHYSIK*, J. SPRINGER, BERLIN, 1929, VOL. IV.

that reaches the earth, at stations which were established in appropriate locations throughout the world; and since 1924 the Mount Wilson Observatory has kept records of the variations of the ultra-violet light received from the sun. Both phenomena have been found to move in cycles, and this confirms the proposition that there is an actual variability in the sun's radiation. The solar cycle has been ascertained in many other manifestations of solar activity—the shape of the corona, the area of the “faculae” or “bright” spots, the prominences in the sun's limb, and other phenomena.

Recently it has been noticed that a close relationship appears to exist between this solar cycle and various terrestrial phenomena. Among these may be mentioned the established connection between the solar cycle and variations in the earth's magnetic field⁶—the timing of magnetic storms, the state of radio reception,⁷ the thickness of the skin of fur-bearing animals, the thickness of tree rings.⁸ Further relationships between the solar cycle and terrestrial phenomena which have been claimed to exist but which have not yet been satisfactorily proved, could easily be enumerated. The work of the Permanent Committee of the International Research Council appointed to further the study of solar-terrestrial relationships will probably throw new light on this problem.

With this considerable amount of new data available, it seems worth while to attempt a fresh statistical investigation of Jevons' hypothesis. We have not only better and more complete astronomical data, but also more accurate economic measurements, and particularly the advantage of the new statistical techniques.

Sunspot Cycle Varies

In the first place, we find that it is not possible to rely on an exact figure for the length of the sunspot cycle, as Jevons did. There is no exact “period.” According to the Wolfer tables the length has varied in the last three centuries (since the discovery of the existence of the sunspots in 1608, when the telescope was first used by Galileo) between 8.2 and 15 years, as counted from minimum to minimum. The arithmetical average from 1610 to 1913 is 11.215.⁹ According to a statistical investigation of the problem by G. U. Yule,¹ there seems to be no secondary period, and the frequency distribution is similar to that of a

pendulum disturbed by random impulses. Using the crude data available for the period 1749-1924, he obtained, by the harmonic formula, 10.08 years and, by the regression equation, 10.60 years. Employing graduated data and the same methods, he obtained the values of 11.03 and 11.164 years.

C. G. Abbot believes that the true period is probably 22.6 years, between two minima of identical electrical nature (the intervening minima not clearly fixed). He shows that for the last century—the period for which we have reliable data—the deviations from the 22.6-year period have been less than 0.7 year.² On the other hand, H. W. Clough is of the opinion that the variations in the amplitude of the period are consistent and show several cycles of 37, 83 and 300 years. He offers evidence which dates back to 300 A.D., based on records of the aurora borealis, and finds a “normal” value for the period of 11.067 years.³

From all this evidence it is clear that no harmonic analysis or other method based on an assumed fixed period should be used in this investigation. Nor is the method used by Jevons of “counting” the panics and obtaining an average length adequate, because there is no exact average for the solar cycle, and it is difficult to detect all the definite depressions, as well as the actual low points of the economic curves, which should be counted. Furthermore, even if an average is found exactly similar to the solar average, the relationship would be nonexistent if the “tops” and “bottoms” of the individual business cycles showed a disagreement with the solar cycle.

Better Method

Probably the best method is to correlate the time series of sunspots or other solar phenomena and the time series of economic activity.

Following this method, we have chosen the solar data of the Greenwich and Kodaikanal Observatories, published by the Royal Astronomical Society. They are the most reliable sources because they consist of daily measurements taken from photographs of the area of the sunspots, measured in millionths of the solar visible hemisphere and given in mean daily averages. It is true that these data go back only to 1874, whereas the “sunspot numbers” of Wolfer are available since 1749; but Wolfer's later ones are more or less arbitrarily measured by a formula which combined groups with the number of spots, and the data for the years previous to 1833 are not the result of systematic observations.⁴ Other reasons for using the Greenwich observations are that they publish similar data for the area of the faculae (or “bright” spots in the solar surface) which, varying for the same

6. A STUDY OF THIS SUBJECT COVERING THE PERIOD 1873-1902 IS TO BE FOUND IN MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, VOL. 63, P. 462.

7. STETSON, H. T., “SOLAR ACTIVITY AND RADIO RECEPTION,” MONTHLY WEATHER REVIEW, JANUARY, 1933, P. 1.

8. THE DATA ON THIS, DISCOVERED BY DOUGLASS, EXTEND BACK FOR OVER 1,000 YEARS. SEE THE COMPILATION QUATERNARY CLIMATES, CARNEGIE INSTITUTION, WASHINGTON, 1925.

9. HANDBUCH . . . , LOC. CIT., P. 99. SOLAR CYCLES ARE MORE CLEARLY DEFINED BY TAKING DATA OF MINIMA ACTIVITY THAN THEY ARE BY RESORT TO MAXIMA.

1. “ON A METHOD OF INVESTIGATING PERIODICITIES IN DISTURBED SERIES, WITH SPECIAL REFERENCE TO WOLFER'S SUNSPOT NUMBERS,” BY G. UDN YULE, PHIL. TRANS. ROY. SOC., 1927, VOL. 226, P. 267.

2. REPORTS OF THE CONFERENCE ON CYCLES, CARNEGIE INSTITUTE, WASHINGTON, 1929, P. 47.

3. “THE 11-YEAR SUNSPOT PERIOD. SECULAR PERIODS OF SOLAR ACTIVITY AND SYNCHRONOUS VARIATIONS IN TERRESTRIAL PHENOMENA,” BY H. W. CLOUGH, MONTHLY WEATHER REVIEW, WASHINGTON, APRIL, 1933, P. 99.

4. SEE W. J. S. LOCKYER, “THE SOLAR ACTIVITY 1833-1900,” IN MONTHLY NOTICES ROYAL ASTRONOMICAL SOCIETY, VOL. 61, P. 43.

cycle, will be useful for us as another index to check; and that the economic data of American business previous to 1874 are not as complete as the data since that time. And a final reason is that henceforth we shall deal entirely with facts subsequent to the Jevons investigation.

For the economic data we shall use first the index compiled by Dr. W. M. Persons, not only because it covers exactly the same period but because it gives partial indices—of crops, minerals and manufactures. There is little difference between the various authoritative yearly indices of American business activity; several of these have been tried graphically, with about the same results

Dr. W. M. Persons has demonstrated that the index of the physical production of crops corresponds closely to the changes of yield per acre (the correlation of the changes from year to year reaches the high figure of $\pm .92$).⁵ Therefore this is a good index to use in the investigation to find out whether the solar cycle affects the total amount of production of crops in the United States. Since the purpose of the investigation was to test the Jevonian assumption of the existence of an 11-year cycle in both phenomena, and since this cycle can be hidden behind year-to-year fluctuations, and since Persons has noted that sharp year-to-year fluctuations are a clear feature of the index of crops,⁶ the necessity of smoothing the data is evident. A 3-, 4-, or 5-year moving average would have been a simple method to employ, but this method involves the prejudice of assuming the existence of a 3-, 4-, or 5-year cycle, and will not correctly reveal the turning points. This defect has been analyzed by Dr. F. R. Macaulay in his pioneering book.⁷ Following Macaulay's sug-

gestion, we have used a weighted moving average of seven terms whose "graduation weight diagram" shows a smooth curve roughly comparable with the ones of Macaulay.⁸ The formula is

$$d = \frac{a + 3b + 5a + 6d + 5e + 3f + g}{24}$$

Chart I

The comparison of the two curves appears in Chart I, in which the actual data and the smoothed values are both pictured. The absence of correlation between the cycles of the solar curve and the smoothed line of crops is clear.

The results of the graduation of the crop figures are interesting, because they not only show the nonexistence of a definite cycle corresponding to the solar cycle but also evidence of fluctuations which have been detected by other investigators. Something like a pronounced wave is apparent. The graduated line crosses the normal line downward in 1885-86 and in 1919-20, i.e. 34 years apart. This long cycle of 33 or 35 years is quite obvious in the chart, altho the length cannot be determined with exactness, owing to the shortness of the period considered. This is evidently the so-called Brückner cycle¹ that has been found in so many agricultural series and in other

8. *IBID.*, PP. 77-79. WE CANNOT USE MORE TERMS WITHOUT INTERFERING WITH THE 11-YEAR PERIODICITY.

9. FROM A PRACTICAL POINT OF VIEW THIS METHOD HAS THE ADVANTAGE THAT IT CAN BE USED BY TAKING A 4-YEAR MOVING AVERAGE OF A 3-YEAR MOVING AVERAGE OF A 2-YEAR MOVING AVERAGE. AND THIS IS VERY IMPORTANT IN AN INVESTIGATION LIKE THE PRESENT ONE IN WHICH SO MANY CURVES MUST BE TESTED.

1. E. BRÜCKNER, PROFESSOR OF GEOGRAPHY AT THE UNIVERSITY OF BERN, DISCOVERED IT IN 1890 WHEN STUDYING THE RECORDS OF THE LEVEL OF LAKES WITHOUT OUTLETS. THE OSCILLATIONS WERE FOUND IN ALL THE LAKES CONSIDERED AND WERE ALIKE (THE LAKES WERE DISTRIBUTED IN THE FIVE CONTINENTS). THE AVERAGE FOR THEM, FROM 1020 TO 1890, WAS 34.8 YEARS (BUT THE INDIVIDUAL CYCLES VARIED FROM 20 TO 50 YEARS). SEE SIR RICHARD GREGORY'S "WEATHER RECURRENCES AND WEATHER CYCLES," IN MONTHLY WEATHER REVIEW, DECEMBER, 1930, P. 485.

5. WARREN M. PERSONS, *FORECASTING BUSINESS CYCLES*, NEW YORK, 1931, P. 192.

6. *OP. CIT.*, P. 193.

7. F. R. MACAULAY, *THE SMOOTHING OF TIME SERIES*, NEW YORK, 1931.

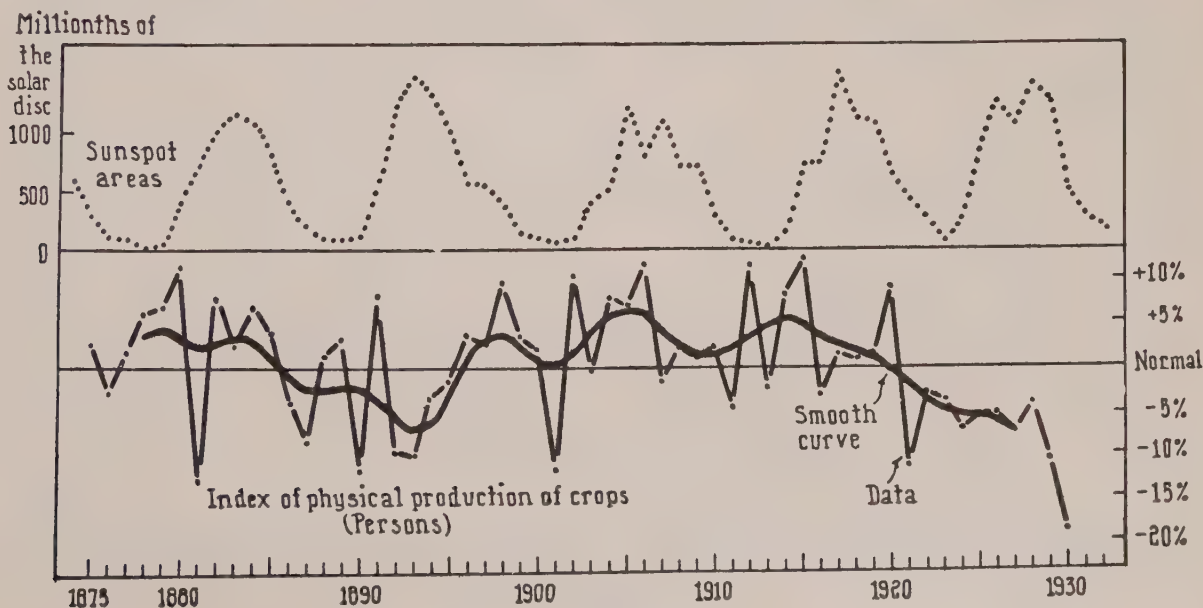


CHART I

terrestrial phenomena. The last maximum year given by Brückner as "wet and cold or wet or cold" was 1880, and this figure agrees approximately with our graduated curve, since the top of it was about that date.

This result coincides with the findings of Moore, referred to above. He notes that a 33 1/3-year cycle is predominant, and we know that the length of the Brückner cycle is quite variable.²

In addition to this wave, our curve shows five cycles of 6, 6, 8, 8 and 8 years, starting in 1881 and ending in 1917, making an average of 7.2 years. At the end of the curve, however, there is no definite cycle. Probably this kind of fluctuation is the same as that referred to by Moore as an 8-year cycle, and by Clough as a 7-year cycle.²

Chart II

Persons' index of the physical production of

2. SEVERAL ATTEMPTS HAVE BEEN MADE TO CORRELATE THE BRÜCKNER CYCLE WITH SOLAR ACTIVITY. SEE "NOTES ON LAKE LEVELS," BY J. W. SHUMAN, IN MONTHLY WEATHER REVIEW, MARCH, 1931, P. 97; AND "THE SOLAR ACTIVITY 1833-1900," BY W. J. LOCKYER, IN MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, VOL. 61, P. 43. WE MADE AN INVESTIGATION ABOUT THE POSSIBILITY OF A DIRECT CORRELATION OF THE SECULAR TREND OF THE SUNSPOT SERIES (AS SHOWN BY AN 11-YEAR MOVING AVERAGE OF THE SUNSPOT NUMBERS, 1749-1933) WITH THE "LONG WAVES" OF THE ECONOMIC SERIES. THE RESULT WAS NEGATIVE. THE SOLAR SECULAR CYCLE SHOWS SOMETHING LIKE TWO WAVES WITH BOTTOMS AROUND 1810 AND 1900. A GRAPHIC COMPARISON WITH WHOLESALE PRICES IN ENGLAND SHOWED SOME AGREEMENT UNTIL 1870. BUT NO CORRELATION AFTERWARDS. SIMILAR RESULTS WERE OBTAINED WITH THE CURVE OF THE PRICE OF BRITISH CONSOLS FOR THE WHOLE PERIOD. THE MAIN SOLAR SECULAR CYCLE SEEMS TO HAVE A LENGTH OF ABOUT 80 YEARS, AND THEREFORE CANNOT BE CORRELATED WITH THE "KONDRATIEFF" CYCLE OF ABOUT 50 YEARS. IT IS INTERESTING TO NOTE THAT THIS 50-YEAR CYCLE IN ECONOMICS WAS CITED BY JEVONS AS HAVING BEEN DISCOVERED BY A DR. CLARKE IN 1847. SEE INVESTIGATIONS . . . , P. 223.

3. H. W. CLOUGH, "AN APPROXIMATE SEVEN-YEAR PERIOD IN TERRESTRIAL WEATHER, WITH SOLAR CORRELATION," IN MONTHLY WEATHER REVIEW, OCTOBER, 1920.

manufactures, after the same smoothing process used previously for the crop index, showed a surprising result. Five cycles appeared clearly between the actual bottoms of 1876 and 1932, making an average of 11.20 years. The average of the last five sunspot cycles (not counting the present minimum, which is not yet clearly established) is 11.16 years. But a graphic correlation of both curves (see Chart II) showed that the correlation should be inverse, i.e. increase of sunspots correlating with decrease in business. The main explanation is in the known fact that the solar cycle takes longer to fall than to rise; and the 11-year business cycles of our smoothed curve showed clearly a rise much slower and longer than the fall in the depression periods. A graphic comparison with the solar curve inverted showed, nevertheless, that to get a high correlation through agreement of tops and bottoms a lag of three or more years was necessary, i.e. the solar curve three years ahead of the business curve. The necessity of introducing such a long lag to produce the best correlation seemed to us more an indication of the correlation's being accidental than a proof of the true relationship between both curves. But the fact that the varying length of the five individual solar cycles showed individual resemblances to those of the respective business cycles was a strong argument against closing the investigation at this stage. The other solar curve of the Greenwich records was used, with a similar result, i.e. the solar faculae, when inverted, showed the same relationship and lag.

Solar Radiation

The curves of solar variation so far considered are those of the variations as seen in the sun. The possibility of a different timing of the variation of the solar cycle as received on the earth was sought. The variations of the solar

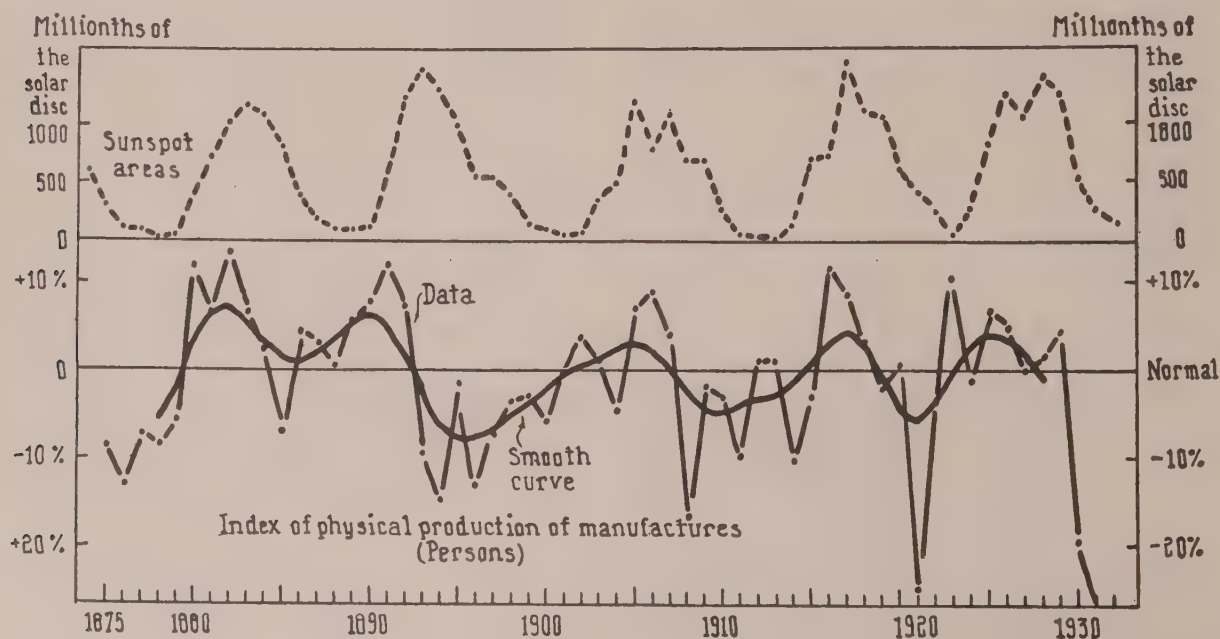


CHART II

radiation as measured by the Observatories of the Smithsonian Institution are available since 1919, and altho they show clearly the 11-year cycle the timing is not the same as that of the sunspots. According to Dr. Abbot, under whose supervision these observations were made, "as indicated by all our observations, the solar radiation rises to a maximum with *medium* sunspot numbers and declines thereafter as sunspots increase."⁴ This is exactly the same behavior as that observed in the correlation between the sunspot curve and the business curve. A long record of solar-radiation observations is not available, and therefore a test for the whole period is not possible.

Chart III

Since the kind of relation described by Dr. Abbot as existing between the sunspot curve and the solar radiation is more or less a description of the behavior of a first-difference curve in relation to the curve of the original data, we constructed a curve of the yearly changes of the area of the solar spots. After this curve was smoothed in a way similar to that of the economic curve, and both were plotted together without the aid of a lag, and the zero lines made to coincide without changes in the scales, the results were striking. The relationship, as shown on Chart III, is much higher than was expected, because the shape of all five individual cycles is surprisingly

4. REPORT OF THE CONFERENCES ON CYCLES, WASHINGTON, 1929, P. 75. THIS DIFFERENCE IN TIMING BETWEEN THE SUN-SPOT CURVE AND OTHER SOLAR TERRESTRIAL CURVES HAD BEEN SHOWN GRAPHICALLY BY F. H. BIGELOW IN A TREATISE ON THE SUN'S RADIATION AND OTHER SOLAR PHENOMENA, NEW YORK, 1923, 234.

close. . . .

When the curve of the first-differences of the solar-faculae series was constructed, it showed the same results, and the correlation with business remained as before, seen also in Chart III.

Chart IV (SEE PAGE 228)

The same investigation was made regarding the index of physical production of minerals, which together with that of crops and manufactures forms Dr. W. M. Persons' index of physical production in the United States. The three indexes, compared with the solar cycle, may be seen in Chart IV.⁶ The chart shows clearly the surprising fact that there is no correlation between the solar cycle and the fluctuation of crops, but that there is a close correlation between the solar cycle and the other indexes of physical production. The coefficient of correlation between the smoothed curves of yearly changes in sunspots and production of manufactures proved to be $+.690 \pm .049$. Since $+.1.00$ would indicate absolute agreement the correlation is a high one.

Chart V (SEE PAGE 228)

As the correlation is so surprising, another.

5. THE TWO TOP CURVES REPRESENT THE FIRST DIFFERENCES, AND THE FIRST DIFFERENCE SMOOTHED, OF THE SUNSPOT AREAS DEPICTED IN CHARTS I AND II.

THE TWO MIDDLE CURVES REPRESENT THE FIRST DIFFERENCES AND THE FIRST DIFFERENCES SMOOTHED, OF SOLAR FACULAE.

THE TWO BOTTOM CURVES SHOW THE RELATIONSHIP BETWEEN THE SUNSPOT CURVE (SMOOTHED) AND PERSONS' INDEX OF MANUFACTURES (SMOOTHED).

6. PERSONS' UNADJUSTED DATA ARE GIVEN IN HIS FORECASTING BUSINESS CYCLES, PP. 182-183.

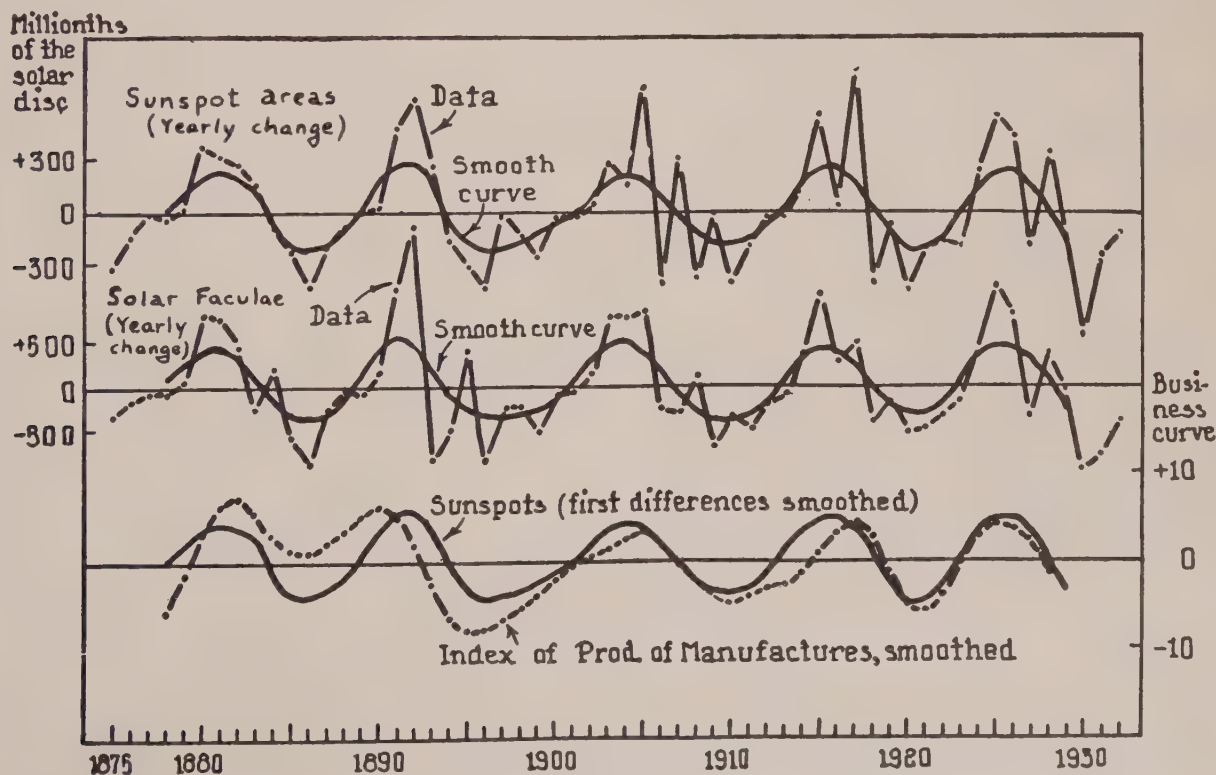


CHART III

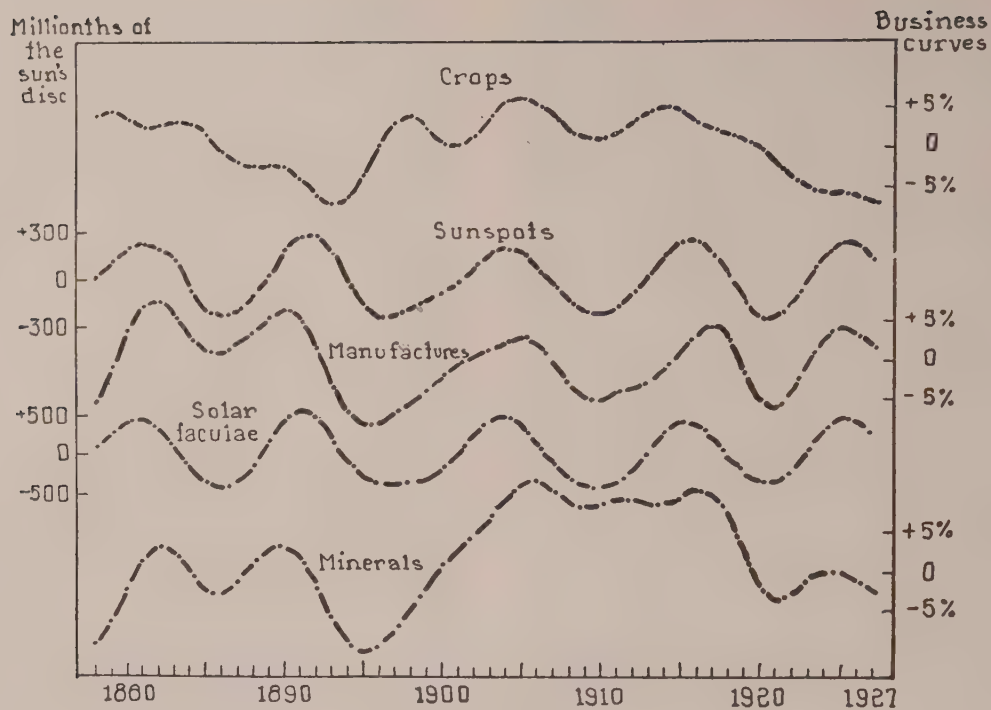


CHART IV

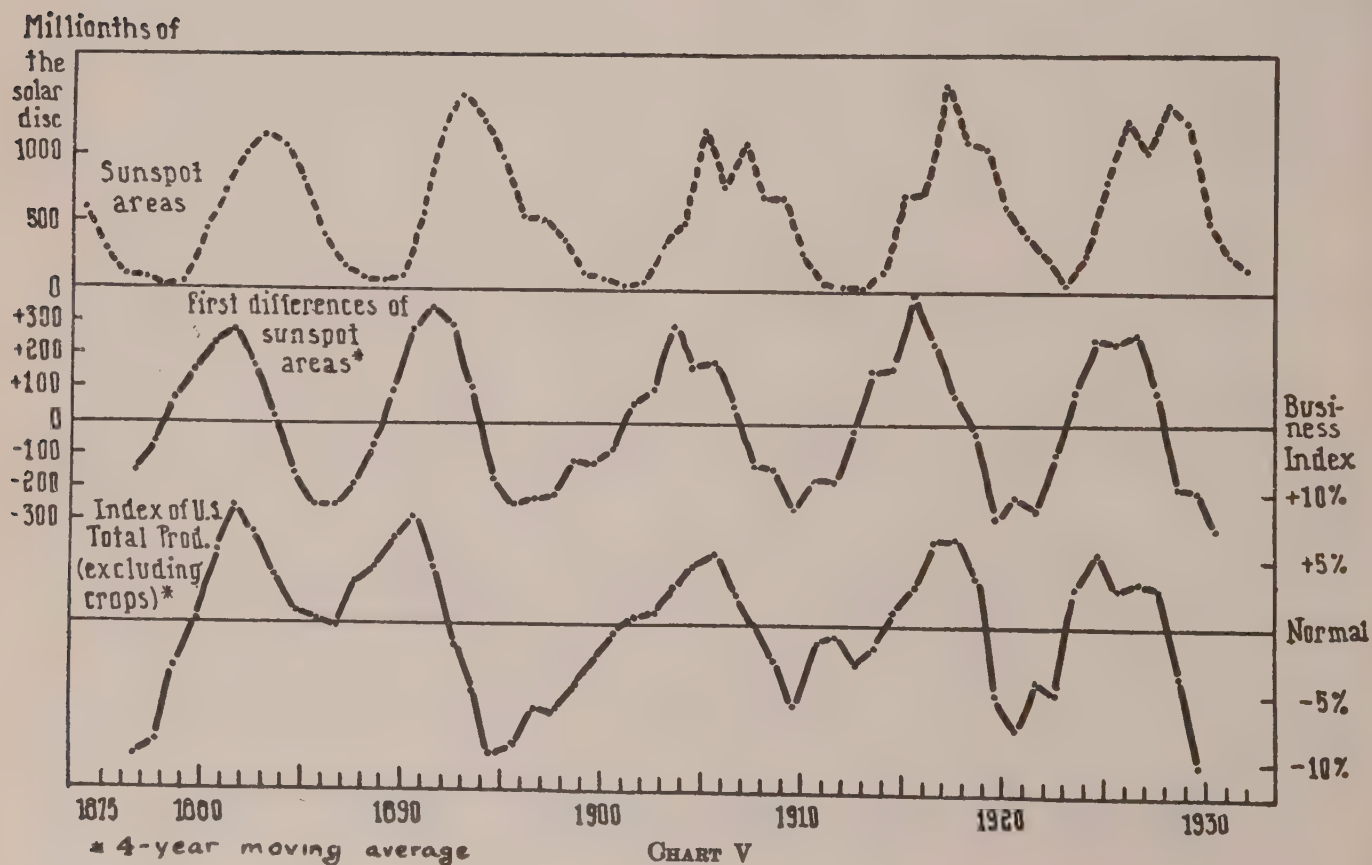


CHART V

kind of comparison was devised as a check. With Persons' data we have constructed an index that includes total physical production, excepting crops (using Persons' weights: Manufactures, 56; Minerals, 8). Starting on the assumption of the existence of something like a 3 1/2-to 4-year cycle in business series, which so many investigators have found,⁷ it is clear that a 4-year moving average will eliminate that kind of fluctuation, and all the other longer cycles ought to remain. When that was done and the resulting curve was plotted with the solar curve, the same clear correlation was revealed.⁸ See Chart V.⁸

Chart VI

As a further step without regard to smoothing, we took the actual figures of this total index of physical production (excluding crops)⁹ and compared it with the yearly changes of the areas of solar faculae, which are a better solar index for uses without smoothing than are sunspots, because the faculae areas are twice as large as the spots. The results are shown in Chart VI. Although a first difference curve is subject to sharp fluctuations, the crude data of the graph show that the relation is visible without any mathematical manipulation. The solar curve reached the lowest point of the entire 56-year period in 1929-30.

We have not found in the astrophysical literature references to this cycle of the yearly

7. SEE W. C. MITCHELL, *BUSINESS CYCLES*, NEW YORK, 1927, PP. 344 AND 385.

8. THE COEFFICIENT OF CORRELATION REMAINED HIGH: $\pm .644 \pm .055$.

9. THE PERSONS "TOTAL" INDEXES COULD NOT BE USED HERE BECAUSE, AS WE HAVE SEEN, THEY INCLUDE CROP FLUCTUATIONS WHICH ARE QUITE DIFFERENT FROM THOSE OF NON-AGRICULTURAL PRODUCTION.

changes of solar phenomena, but Dr. Bauer of the Carnegie Institution is reported to have said that "as a combined result of his investigations to date, he found that, in general, the most successful measure of solar activity, especially when comparisons between solar and terrestrial data are attempted for smaller intervals than a year—a month, let us say—is a quantity indicative of the amount of *variability* of sunspottedness during a given period."¹ It is curious that our graphs show the best correlation with curves of sunspot *variability*, tho' yearly instead of monthly.

Another attempt was made, with an entirely different method, to test the existence of this curious direct correlation of the solar cycle with the production of manufactures—curious because it appears regardless of the fact that there is no clear connection either of the solar cycle with crops or of the crop cycle with the business cycle.

The clearest sign of the existence of a cycle in the sun is the so-called "Spoerer Law" of the variation of the latitude of the sunspots. Instead of a curve being formed by a variability that increases and decreases, like the total amount of spots, the latitude measurements are broken with the beginning of a new cycle every 11 years. In other words, at the beginning of the cycle the spots are distributed in two belts, between 20° and 40° latitude at both sides of the equator. Then during the whole solar period they appear each year nearer to the equator, and at the end of the period they are centered around it at about 6° on either side. Then the new cycle is suddenly announced by the appearance of new spots at about 40°; and, as the spots of the old cycle near the equator disappear, the two belts of the new cycle

1. REPORTS OF THE CONFERENCES ON CYCLES, WASHINGTON, 1929, P. 17 (ITALICS ARE DR. BAUER'S).

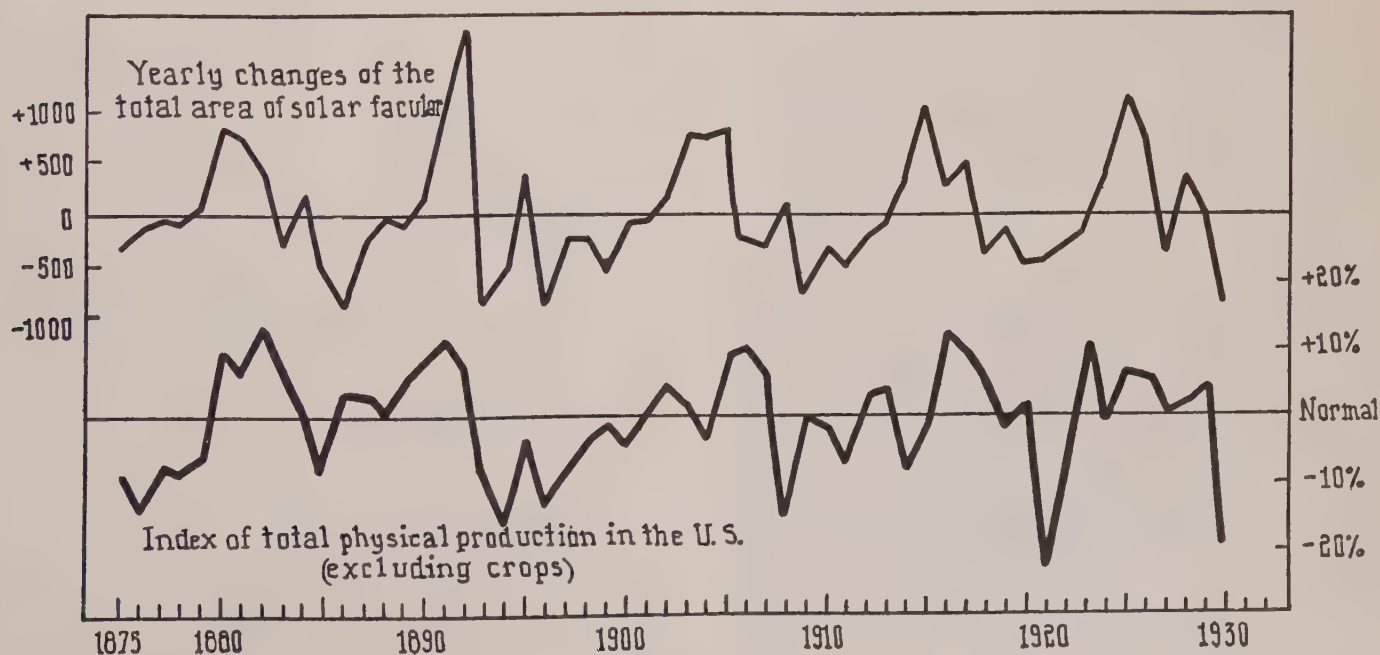


CHART VI

are being formed in the higher latitudes.²

Chart VII

With this phenomenon in mind, a frequency distribution was made of the yearly figures of the index of physical production of manufactures,³ according to the mean latitude of the sunspots during the year (given by the Greenwich records). See Chart VII. The results are as follows:

Number of Years (for Period 1875-1932) in Which the Index of Manufactures Was:

LATITUDE OF HIGH SUNSPOTS	NORMAL (OVER 105)	LOW (BELOW 95)	PERCENTAGE OF (A) IN TOTAL	
	(A)	(B)	(C)	
Above 21°	1	2	20	
19° to 20.99°	3	1	75	
17° to 18.99°	4	2	66	
15° to 16.99°	2	2	50	
13° to 14.99°	4	2	3	44
11° to 12.99°	1	3	2	17
9° to 10.99°		9	4	0
7° to 8.99°		4	6	0
Below 7°			1	0

As can be seen from the last column, the percentages show, with the exception of the first one, a consistent law. It may be noted that the years which have an average latitude of sunspots of more than 21° are the rare years in which spots in higher latitudes of a new cycle are averaged with the lower latitudes of the dying old cycle; hence the mean value is a somewhat artificial figure.

In a more condensed form the same results are tabulated in the following table, according to the years in which the latitudes of the spots were above or below the mean latitude for the whole period, which proved to be 12.5°. See Chart VIIb.

Distribution of the Yearly Indices of Production of Manufactures, 1874-1932

MEAN LATITUDE OF SUNSPOTS	NUMBER OF YEARS	YEARS WITH THE INDEX ABOVE NORMAL	YEARS WITH THE INDEX BELOW NORMAL
Above 12.5°	29	20	9
Below 12.5°	29	9	20

There seems, therefore, to be some relation between the existence of sunspots (or rather of disturbed focus of solar activity, as the faculae and other phenomena follow the Spoerer Law) near the equator and times of depression. It is generally accepted that the electrical corpuscles shot away by the solar vortex formed by the spots

2. SIMILAR PHENOMENA OCCUR WITH THE FACULAE, ALTHO THE LATITUDES ARE DIFFERENT. THIS LAW IS PERFECTLY PORTRAYED IN THE SO-CALLED "BUTTERFLY DIAGRAM," IN WHICH SUNSPOTS ARE PLOTTED IN RELATION TO TIME AND LATITUDE. SEE HANDBUCH. . . , QUOTED ABOVE, VOL. 4, P. 98.

3. WE HAVE PREFERRED TO USE THIS INDEX AND NOT THE ONE OF TOTAL PRODUCTION, IN ORDER TO EXCLUDE THE CROP PHENOMENA, WHICH, AS WE HAVE SEEN, FLUCTUATE WITHOUT DIRECT RELATION TO THE SOLAR CYCLE.

have a tendency to follow radial straight lines.⁴ In the extreme case of following the radial straight line only, we find that only the spots in the zone below 7° 15' around the solar equator could affect the earth, because those are the limits of the inclination of the earth's orbit in relation to the solar equatorial plane. This hypothetical case is cited here merely to stress the fact that the spots in lower latitudes ought to affect the earth more strongly than the others;⁵ and because the preceding table shows that the appearance of

4. S. CHAPMAN, AN AUTHORITY ON SOLAR-TERRESTRIAL RELATIONSHIPS, THINKS THAT "PROBABLY 90 PER CENT OF THE ATOMS WILL FINALLY HAVE VELOCITIES INCLINED AT LESS THAN 100 OF THE RADIUS." IN MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, MARCH, 1932, P. 415.

5. THE INTERNATIONAL ASTRONOMICAL UNION BEGAN TO PUBLISH IN 1928 DAILY DATA OF THE SUNSPOTS IN THE CENTRAL ZONE "FOR THE RESEARCH OF THE RELATIONSHIPS BETWEEN SUN PHENOMENA AND CERTAIN TERRESTRIAL PHENOMENA." FOR CHARACTER FIGURES OF SOLAR PHENOMENA, SEE BULLETIN, ZURICH, MARCH, 1928.

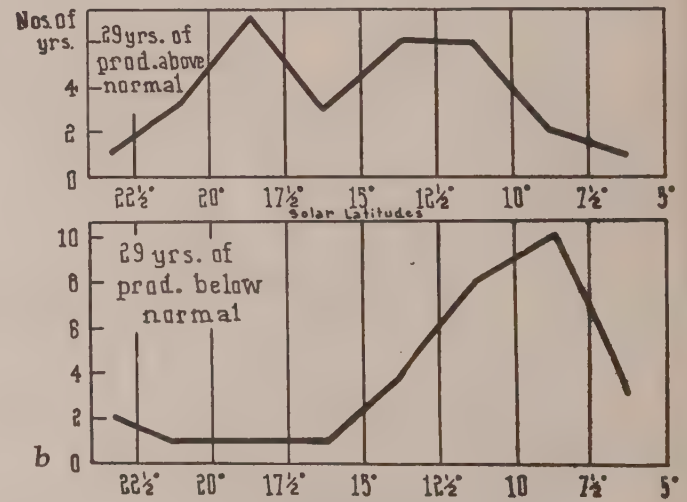
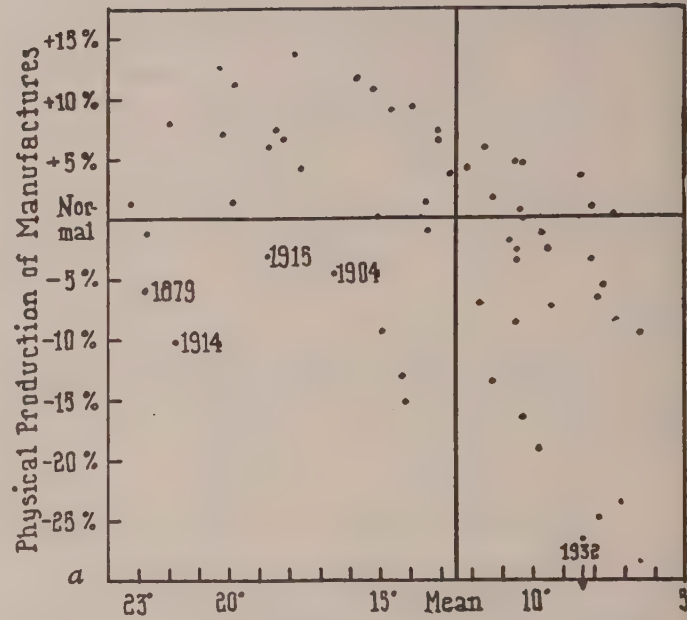


CHART VII

spots in lower latitudes is somewhat associated with depressions, and their absence with prosperity.

Following this idea as a working hypothesis, we made a tabulation of the area of the sunspots as given daily in the Greenwich Heliographic Results, by degrees of latitude for the period 1902-31.⁶ This enabled us to have a complete record (preceding tabulations were available only to 1902)⁷ for the purpose of statistically delimiting a central zone whose curve of spottedness showed a direct correlation with the business curves without the aid of lags, which was necessary when the total of all the zones was taken. The result showed that such a curve was possible, and that the lag was reduced to one year or perhaps less, but that for that the data ought to be reduced to the absolute minimum limits of $7^{\circ}15'$ to $-7^{\circ}15'$; and even then the correlation was much smaller than that obtained with the curve of the yearly changes, mentioned in previous paragraphs. Given different statistical weights for the spots according to their distance from the earth's plane, it would be possible to obtain a closer fit, but this suggestion was not followed because the weights would be somewhat arbitrary.

Conclusion

Summing up, we can say that *from a statistical point of view* there appears to be a clear correlation between the major cycles of non-agricultural business activity in the United States and the solar cycle of 11 years; but so far we have been unable to determine whether the best correlation is with the curve of the total amount of the solar disturbances with a lag of several years, or with the cycle formed by the yearly increase or decrease in disturbances in the solar surface (spots, faculae, etc.) or with the existence or absence of spots pointing directly to the earth in the solar central zone, or through some other feature of the solar cycle. *From a logical point of view* all the evidence accumulated seems to show that it is hardly possible to believe that the relations revealed are wholly accidental. Therefore we are obliged to seek reasons.

Pigou's Hypothesis

Altho ever since the days of John Mills the psychological explanation of business fluctuations has been outstanding among the many competing theories, it is perhaps at the present time as much in vogue as ever before, probably more because of the expository abilities of its best known exponent than from any inherent merits which have so far been found in the theory itself. Recent events have contributed to enhance its popularity.

6. WITH THE ASSISTANCE OF THE FACILITIES OF THE HARVARD ASTRONOMICAL LABORATORY. THIS INVESTIGATION REPRESENTS THE CONTINUOUS LABOR OF ONE MAN OVER A PERIOD OF THREE MONTHS.

7. "MEAN DAILY AREAS OF SUNSPOTS FOR EACH DEGREE OF SOLAR LATITUDE FOR EACH YEAR FROM 1874 TO 1902 AS MEASURED BY THE ROYAL OBS. GREENWICH." MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, VOL. 63, P. 452.

The last depression has converted many people to the school of thought which maintains that the business cycle is mainly a psychological phenomenon, that sudden changes in the psychological status of the community accompany the change from prosperity to depression, and vice versa. Professor Pigou, now the standardbearer of this theory, has maintained that because of the psychological interdependence of business men, an error of optimism in forecasting the future state of business gradually spreads and becomes general throughout the business community. When the error is discovered, it generates a reaction in the form of an error of pessimism, which also rapidly spreads and leads to the opposite extreme. Reversal of the process explains a return to prosperity.⁸

A Discrepancy

In the last few years, however, it has been clear that at times when there is an abundance of technical features favoring the return of prosperity—easy money, the wearing out of goods and equipment, government agencies to aid recovery—yet revival is impeded by the failure of the public's psychology to react to such favorable external stimuli. This is a factor that cannot be explained by Pigou's theory. Why do the psychological factors fail to begin operating when all the necessary background for their inception is laid out? Why does the timing of these waves of optimism and pessimism seem independent of actual business conditions? Why does recovery, when all seems in readiness, have to wait for some outside impetus? It is fairly easy in economic theory to explain *how* all the features of the business revival engender one another, once the wave has started, but much more difficult to explain *why* it sometimes starts unexpectedly at a given moment and fails to start when it logically should.

To reconcile the psychological theory of the business cycle with the findings of the preceding pages, we need then to assume that the variations of solar activity affect directly, or through some terrestrial mechanism, the psychological reactions of human beings. It is not necessary to claim that the influence is continuous (tho that would not be impossible), but only that it sets in when the psychological wave of optimism has been well under way for years and has created in itself all the elements for the next phase of the business cycle; when, as Pigou says, the boom is at its maximum and the mass psychology at high pitch. Then some great disturbance of the solar activity can affect mass psychology, which is in a receptive mood, and can produce a "brainstorm," the start of the wave of pessimism that, according to Pigou's theory, will engender in itself all the characteristics of the depression phase.

The latest investigations of the solar-terrestrial relationships point in this direction. Biology is the last one to be added to the long

8. A. C. PIGOU, INDUSTRIAL FLUCTUATIONS, LONDON, 1927 AND 1929.

list of sciences in which the solar cycle manifests an influence. The correlation between birth and death rates and the main waves of business fluctuation is a well-known and established fact in the field of the social sciences. The usual explanation has always been that business conditions affect demographic phenomena, in other words that the business cycle is a cause of cycles in vital statistics. But some doubts have arisen recently about this connection. We have seen in the preceding discussion of Huntington's theory that the correlation between business cycles and death-rate cycles actually exists but is the *reverse* of the one Huntington thought logical. Now that we have seen that business cycles follow the solar cycle, we naturally are inclined to believe that the "logical" correlation between death rates and business is because the sun is influencing both phenomena.

With respect to the birth rate the direct correlation existing with business seems logical; no one can deny that business affects marriage rates. But this cannot explain the entire matter, if we are to give credence to a study made not long ago by M. B. Hexter, who found that the curve of conceptions *preceded* the fluctuations of business activity. The discovery so bewildered its author that he found no way out of it other than to suggest that the psychological reaction of prospective fathers causes business cycles.⁹

In animal life some correlations with solar cycle have also been known . . .

Perhaps the first observation of direct biological effect¹ was the investigation of J. Vallot, Director of the Mont Blanc Observatory, in collaboration with two physicians.² According to the report presented by them to the Academy of Medicine of Paris, they started their investigation after it was found impossible to explain on meteorological grounds the sudden changes in the course of chronic illness that they observed in the hospital.

To investigate the possibility of a cosmic cause, the two physicians kept a record for nine months of the daily course of the illness of 237 patients, noting the sudden changes and classifying them according to their intensity. At the same time an astronomer took daily observations of the passage of sunspots through the central meridian of the sun, i.e. when they pointed directly at the earth. The result of the comparison of the two different sets of observations was that tho

there were sunspots only 29 per cent of the time, 51 per cent of all the disturbances recorded in the condition of the sick occurred during this period; and counting only the major disturbances ("accidents aigus"), 72 per cent of them occurred on days with spots.

Variety of Causes

This kind of investigation on biological effects seems to be retarded by the same difficulty that is holding back other researches on the daily relationship of solar and terrestrial phenomena, i.e. that the origin of the solar activity which produces the disturbances is not known, because sometimes it is associated with spots and at other times seems to come from faculae or prominences or invisible disturbances. S. Chapman, in the latest report of the Committee on the Relationship between Solar and Terrestrial Phenomena, sums up the investigation of the relationship with terrestrial magnetism. He states that altho the severe magnetic storms are associated with large sunspots, other spots bring no effects; and that "there must exist on the sun's surface certain restricted areas—which we have ventured to designate M-regions. . . . They cause terrestrial magnetic disturbances probably by emitting well-defined corpuscular streams. Such solar regions in the individual sense escape observation."³

A. Nodon, a French astronomer who has lately been studying those invisible regions (he calls them "foyer electriques"), has pointed out that their delimitation will solve also the problem of the biological actions in which he is a believer. Recently he has stated that he has undertaken an investigation of the relations of those electrical solar centers with vegetable phenomena and pathological disturbances in human beings, at the University of Bordeaux, in collaboration with the biologist, Dr. Cuvier.⁴

Possible Explanation

We may now turn to the possibilities of the mechanism of the relation. If a direct relation exists between the focus of disturbance on the sun's surface and the biological phenomena on the earth, it may take several forms. Without being committed to any of them, as the whole subject is outside our competence, we shall merely point out two possible explanations:

(1) The mechanism of the relationship may be due more or less to the direct action of the solar rays. Solar radiation is composed of many different rays, of which the visible light accounts for less than 40 per cent, the rest being distributed between the ultraviolet and the infrared.⁵ While the

9. MAURICE B. HEXTER, SOCIAL CONSEQUENCES OF BUSINESS CYCLES, BOSTON, 1925.

1. WE QUOTE THIS AS THE FIRST INVESTIGATIONS WE KNOW. ALTHO WE ARE AWARE THAT THE SUGGESTION OF THE DIRECT RELATION BETWEEN SOLAR ACTIVITY AND HUMAN AFFAIRS HAS BEEN OFFERED BY MANY WRITERS, BUT IN A MORE OR LESS LITERARY WAY WITHOUT ADDING INDIVIDUAL INVESTIGATIONS ON THE PROBLEM. OF THEM WE SHALL QUOTE THE FRENCHMAN TH. MOREAU IN SEVERAL PUBLICATIONS AND IN VARIOUS PARTS OF HIS BOOK, LES ENIGMES DE LA SCIENCE, PARIS, 1925; AND THE RUSSIAN PROFESSOR CHIJEVSKY, OF WHOSE SUGGESTION OF THE ELECTRIC NATURE OF THE RELATIONSHIP WE SHALL HAVE SOMETHING TO SAY LATER.

2. "DE L'INFLUENCE DES TACHES SOLAIRES SUR LES ACCIDENT AIGUS DES MALADIES CHRONIQUES," BY J. VALLOT, G. SARDOU AND M. FAURE, BULLETIN DE L'ACADEMIE DE MEDECINE, PARIS, 1922, TOME 88, P. 4).

3. INTERNATIONAL ASTRONOMICAL UNION, TRANSACTIONS, VOL. IV, 1932. THE COMMITTEE IS MAINTAINED BY THE INTERNATIONAL RESEARCH COUNCIL.

4. "RECHERCHES SUR L'ACTION DES CENTRES ACTIFS DU SOLEIL," BY DR. ALFRED NODON, IN REVUE SCIENTIFIQUE, PARIS, FEBRUARY, 1934, P. 103.

5. ULTRA-VIOLET RADIATION, BY M. LUKIESH, NEW YORK, 1922, P. 23.

total energy of the sun's rays varies only 2 1/2 per cent between the maximum and minimum of the cycle, the variations are unevenly distributed between different parts of the spectrum. In the ultraviolet section of the spectrum alone the variations are so wide that, as contrasted with a maximum variation in the sun's rays of only 2 1/2 per cent, the ultraviolet light received by the earth from the sun was in September, 1929, for example, almost 39 per cent greater than it was in June, 1932.⁶ In some parts of the spectrum in this zone the fluctuation is even greater. C. G. Abbot, a well-known authority on the subject, says: "Petit, observing with the narrow band of ultraviolet rays at 3.160 A (316 millimicrons) finds alterations of over 100 per cent in their intensity." ⁷

The relation between the sunspots and the ultraviolet ray fluctuations has sometimes been explained by the effect of the electrical particles emanating from the sunspots. As they reach the higher zones of our atmosphere and strike oxygen atoms, they form ozone; and this layer of ozone (the well-known Heaviside-Kennelly layer which, acting as a reflector, makes long-distance radio transmission possible) acts as a screen, absorbing the ultraviolet rays of less than 290 millimicrons of wave length, thus preventing access to the earth's surface of part of the shorter ultraviolet rays. Thus the number of sunspots makes a great difference in the ozone layer, and controls the amount of ultraviolet rays that reach us. In some periods a clear correlation between the sunspot curve and the ultraviolet fluctuations is apparent.⁸

Ultra-violet Rays

C. G. Abbot has emphasized the importance of the control of this ray by the ozone layer, stating that if the ultraviolet rays of less than 290 millimicrons were allowed to reach us, they would destroy human sight and tissues, while if the screening effect extended to the rays of 320 millimicrons, human and animal young would languish with the enfeebling disease of rickets.⁹ But it is also true that this part of the solar radiation is easily absorbed by fog and smoke. There is a possibility of its action in the ionization of the atmosphere, and, according to an investigation by the Harvard School of Public Health, an experimental changing of the quantity

6. THIS PHENOMENON IS MEASURED BY THE MOUNT WILSON OBSERVATORY BY THE RELATION BETWEEN THE ULTRAVIOLET ZONE OF THE SPECTRUM TO THE GREEN ZONE. THIS RATIO WAS 1.24 IN SEPTEMBER, 1929, AND .89 IN JUNE, 1932. AS THE GREEN ZONE, BEING PART OF THE VISIBLE PART OF THE SPECTRUM, VARIES BY LESS THAN 2 1/2 PER CENT, IT IS USED TO MEASURE, BY COMPARISON, THE VARIATION IN THE ULTRAVIOLET ZONE. SEE THE QUARTERLY BULLETIN FOR CHARACTER FIGURES OF SOLAR PHENOMENA. INTERNATIONAL ASTRONOMICAL UNION, EIDGEN STERNWART, ZURICH.

7. SMITHSONIAN INSTITUTION, ANNUAL REPORT, 1927, P. 163.

8. "MEASUREMENTS OF ULTRA-VIOLET SOLAR RADIATION," BY E. PETIT IN THE ASTROPHYSICAL JOURNAL, VOL. 75, P. 193.

9. SMITHSONIAN INSTITUTION, ANNUAL REPORT, WASHINGTON, 1927, P. 163.

of ions in the air absorbed resulted in records of agreeable or disagreeable sensations, depending upon the electrical charge of the ions.¹ But as the research was done with ionizations far greater than normal atmospheric values, perhaps its only value for our purposes is that it is indicative of a possibility. The other possibility of an indirect action of the ultraviolet rays is the one suggested by Abbot. "Ultraviolet rays produce certain changes of chemical structure in fats and oils which are the source of those traces of hormones so extraordinarily important, all out of proportion to their infinitesimal occurrence in the growth and health of animals."²

The rays of the other part of the spectrum, infrared and heat, tho they have more penetrative force, fluctuate very little during the solar cycle. But experiments have been conducted lately in England, by Sir Leonard Hill, upon the psychological effect of the infrared rays.

(2) The mechanism of the relation can be of an electrical nature, and a more or less direct one. It is known that one of the clearer terrestrial effects of the solar variation is found in a cycle of similar length in the magnetic activity of the earth. The effect of the severe magnetic storms associated with the appearance of large sunspots upon telegraphic wires and electrical appliances is one of the most clearly established facts in solar-terrestrial relations.³ The suggestion of a direct electrical effect upon human beings has perhaps been the first one to appeal to the men who had thought of the possibility of a direct relationship. Professor Chijevsky of Moscow University, in a lecture given in Philadelphia in 1927, referred to possibility of the electrical influence of sunspots' "upsetting the electromagnetic equilibrium of men."⁴

The electrical hypothesis had very little utility, however, until the existence of electrical currents in the human body was scientifically proved. This was accomplished in 1929 by E. D. Adrian, a Nobel Prize winner and the outstanding researcher in this new field of electrophysiology.⁵ The fact seems to be established that the form of energy concerned is electrical.⁶

Among the hypotheses concerning the mechanism

1. C. P. YAGLOU, A. D. BRANDT AND L. C. BENJAMIN, PHYSIOLOGIC CHANGES DURING EXPOSURE TO IONIZED AIR. RESULT OF RESEARCH CONDUCTED AT HARVARD UNIVERSITY SCHOOL OF PUBLIC HEALTH, BOSTON, 1933, P. 7.

2. SMITHSONIAN INSTITUTION, LOC., P. 163.

3. SEE F. SANFORD, TERRESTRIAL ELECTRICITY, STANFORD UNIVERSITY, 1931, CHAPTER VI ON MAGNETIC STORMS AND SOLAR ACTIVITY.

4. REPRODUCED IN THE SUNSPOT, SANTA CLARA OBSERVATORY, CALIFORNIA, MARCH, 1927, VOL. 13, NO. 2. HE PUBLISHED HIS THEORY IN RUSSIA IN 1922, ACCORDING TO PITIRIM SOROKIN, CONTEMPORARY SOCIOLOGICAL THEORIES, NEW YORK, 1928, P. 126.

5. E. D. ADRIAN, THE MECHANISM OF NERVOUS ACTION, ELECTRICAL STUDIES OF THE NEURONE, PHILADELPHIA, UNIVERSITY OF PENNSYLVANIA PRESS, 1932, P. 12.

6. SIR LEONARD E. HILL, PHILOSOPHY OF A BIOLOGIST, LONDON, 1930, P. 46.

of the direct link between solar variation and changes in human psychology, it is impossible now to make a choice. Neither do we believe that it is possible, until far more evidence is accumulated, to prove that the social relationship exists at all. The only thing now allowable is to treat the conclusions of natural science as working hypotheses for our purposes. On this basis the investigations have been carried out.

Areas of Non-correlation

If we observe Chart VI,⁷ we see that altho the solar curve coincides with all the major business depressions, there are at least two of the short-period business panics—short ones but sharp—that have no relation to the solar curve. These are the “rich man’s panic” of 1903-04 and the recession of 1913-14.⁸

Curiously enough, these two periods (1903-04 and 1913-14) coincide with periods of a sharp drop in the earth’s average temperature which has been clearly connected by meteorologists with a diminution of the solar radiation received. But the link of connection was through an earthly rather than a solar phenomenon. In May, 1902, the great eruption of Mount Pelee in the Antillee cast into the upper layers of the atmosphere thousands

of tons of volcanic dust which remained aloft for many months, reducing considerably the radiation that came from the sun.⁹

H. H. Kimball has published a record of these disturbances of atmospheric conditions as a result of volcanic eruption, as reflected in the curve of the readings of the pyrheliometer (an instrument that measures the total heat of sunshine) at the stations of the northern hemisphere of the earth. In this record there is a sharp drop of the pyrheliometric curve at the end of 1902, remaining low in 1903 and going back to normal at the beginning of 1905. The next drop of this atmospheric curve is the one due in the great eruption of Katmai in Alaska in June, 1912. The curve returned to normal at the end of 1914.¹

Chart VIII

The two previous great volcanic eruptions that had a similar effect on meteorological records were the Krakatoa eruption of 1883, which made a low in the pyrheliometric records, centering in 1885, and the eruptions of Mount Bogoslov and other volcanoes in 1890, which were related to a low of the meteorological curve at the beginning

7. SEE PAGE 229.
8. ADDITIONAL EVIDENCE OF THE ABSENCE OF CONNECTION WITH THE SOLAR CYCLE IS GIVEN BY THE FACT THAT THE MEAN LATITUDE OF THE SUNSPOTS IN THOSE FOUR YEARS WAS ABOVE 15°. WE HAVE SEEN ABOVE THAT OF THE OTHER FIFTEEN YEARS, IN THE SIXTY-YEAR RECORD OF AMERICAN BUSINESS, THAT WERE ASSOCIATED WITH SIMILAR SOLAR CONDITIONS, TEN OF THEM WERE YEARS OF PROSPERITY AND THE OTHER FIVE NORMAL OR NEAR NORMAL.

9. W. J. HUMPHREYS, PHYSICS OF THE AIR, NEW YORK, 1929, P. 576.
1. H. H. KIMBALL, “SOLAR RADIATION AS A METEOROLOGICAL FACTOR,” IN MONTHLY WEATHER REVIEW, DECEMBER, 1931, P. 472. IN APRIL, 1932, A GREAT VOLCANIC ERUPTION OCCURRED IN THE ANDES BETWEEN ARGENTINA AND CHILE, AND ITS EFFECT HAS BEEN NOTICEABLE IN THE MEASUREMENTS OF SOLAR RADIATION IN THE SOUTHERN HEMISPHERE IN 1933. BUT WHETHER ITS EFFECT ALL OVER THE WORLD IS COMPARABLE TO THE ERUPTIONS CITED ABOVE IS A MATTER OF SPECULATION UNTIL ALL THE WORLD RECORDS ARE ANALYZED.

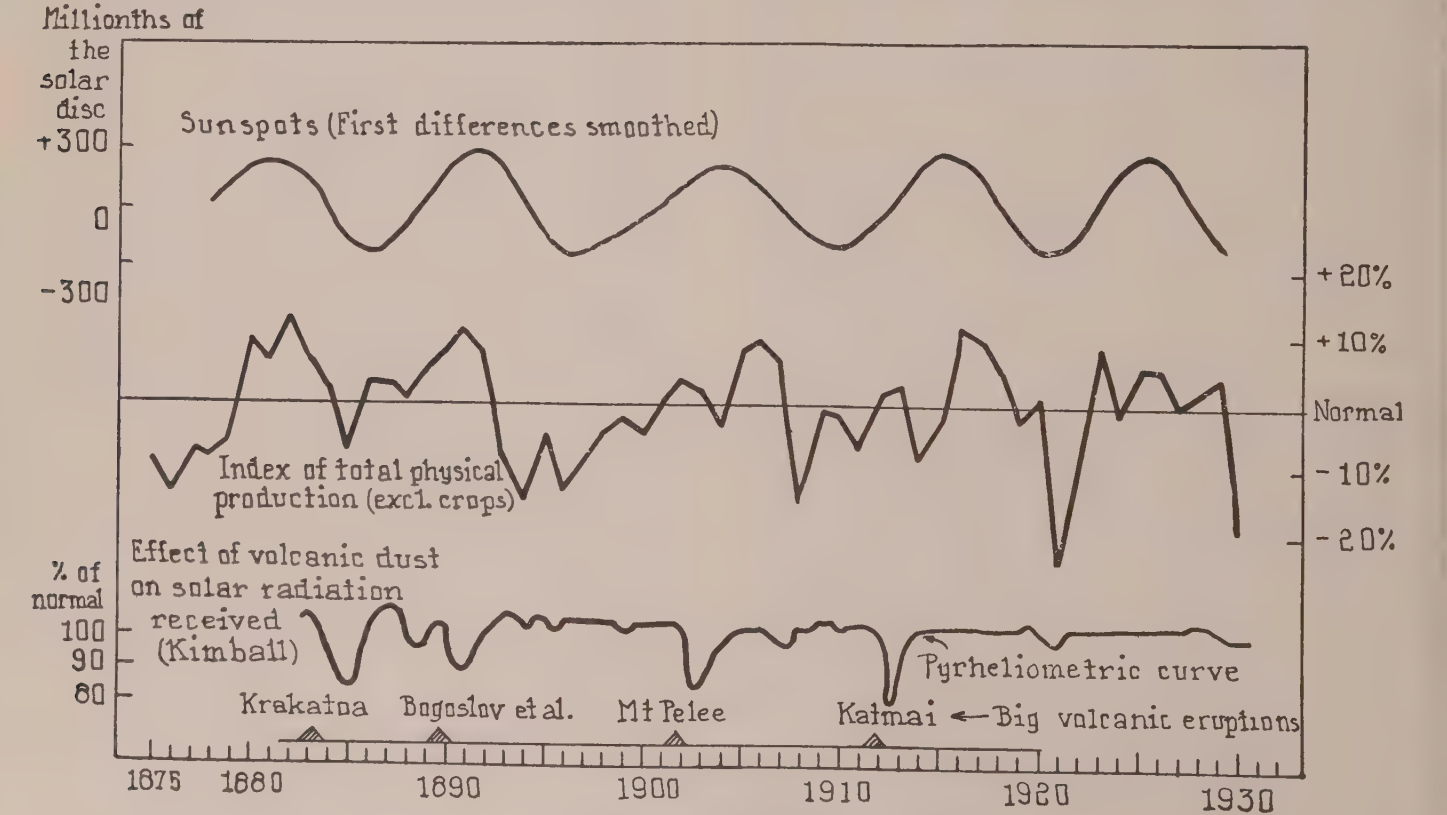


CHART VIII

of 1891. These dates coincide with the depression of the eighties and the Baring panic of 1891, which was the beginning of the long depression of the nineties; but both periods were also lows in our solar curve, as can be seen in Chart VIII, and the dates imply nothing inconsistent with the general reasoning. Perhaps the fact that the business curve on our chart came down in the cycle centering in 1891 before the solar curve and not later, as in the other cycles, can be traced to this atmospheric factor. A similar argument can be used to explain the fact that the business curve makes a low in 1885, a year before the solar low.

It is interesting to note that since 1917, a period in which no great eruptions have altered atmospheric conditions, the business records show a clear case of an 11-year business cycle between the two bottoms of the depressions in 1921 and in 1932.

Humphreys cites the year 1815-16 as the best case of volcanic interference with solar radiation. It was the remarkable "year without summer," and the curve of world temperature reached the lowest point of the century in 1816, after the big eruption of Tomboro in the East Indies.² The amount of material yielded by this eruption has been estimated at 36.4 cubic miles.³ According to the conspectus of Dr. Thorp,⁴ there was a sharp recession in the United States and in England in the middle of 1815, and the year 1816 was recorded as "depression" for the two countries. The next case in the Humphreys chart is the Cosequina eruption, with a definite low in the curve in 1837, and again the conspectus shows an evident recession of business in the two countries during that year.

All this is mentioned merely as additional evidence for the solar hypothesis. Many economists have noticed the difference between short "panics" and long "depressions," and some European economists, such as Bouniatian, have stressed the importance of studying them apart as different phenomena. In the period considered in our investigation, there appears to be a correlation of the long depressions with the 11-year solar cycle, and of the short panics with the accidental drops of the solar radiation received on the earth as a consequence of great volcanic eruptions; furthermore, in some cases the combination of both actions may explain longer depressions.

Chart IX

We may turn now to the idea of Warren M. Persons and his Harvard associates concerning the lag between speculation and business. In the cases of the "rich man's panic" of 1903 and the 1913 panic, the action of the meteorological curve was analyzed in detail in relation to the A, B and C Harvard curves (see Chart IX). According to the Kimball chart,⁵ the pyr heliometric curve began

its downward course in the middle of 1902, several months after the eruption, and reached its lowest point in the first quarter of 1903, then recovered and returned to normal at the beginning of 1905. The Harvard A curve began its drop in the last quarter of 1902,⁶ and remained down until the last quarter of 1903, recovering sharply, especially in the second half of 1904. It is therefore obvious that the meteorological curve preceded the Harvard A curve, but the shape of the two is very different. Altho logically it could not be expected that the A curve would recover as sharply as the physical curve, the evidence is inconclusive. In the 1913 panic there appears to be a similar lag—the meteorologic curve falls sharply in June, 1912, while the Harvard A curve begins its drive in the last quarter of the same year. The meteorologic curve recovered quickly as in the previous case, and at the end of 1917 it was back to normal. But the Harvard A curve, after touching bottom at the end of 1913, remained below normal until the stock market closed in July, 1914, on account of the Great War. The confusion of this event, therefore, plays a large part in the value of our comparison. The cases of the Krakatoa (1884-85) and the Bogoslov (1890-91) eruptions were not analyzed because they fell in

6. NO HARVARD CURVES ARE AVAILABLE TILL JANUARY, 1903. BUT THE FACT HERE REFERRED TO HAS BEEN TAKEN FROM THE BEHAVIOR OF THE PERSONS STOCK PRICES CURVE.

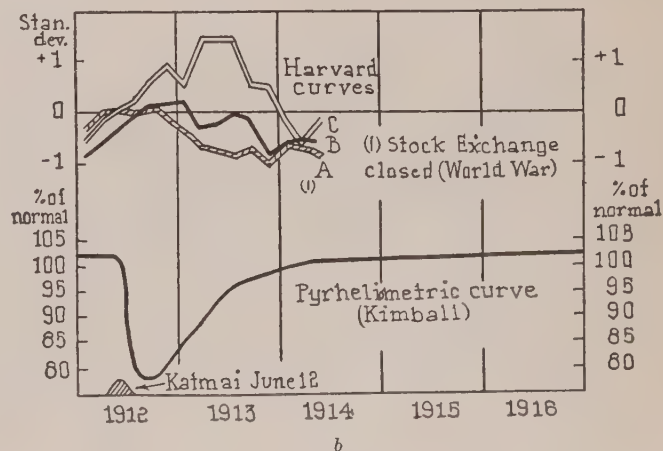
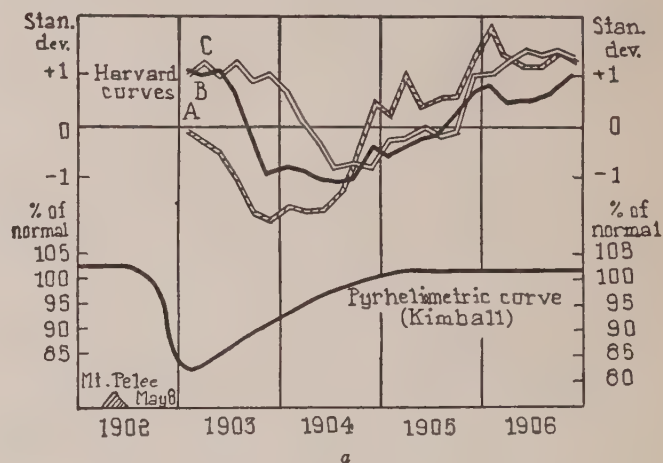


CHART IX

2. OP. CIT., P. 594.

3. G. W. TYRELL, VOLCANOES, LONDON, 1931, P. 91.

4. W. L. THORP, BUSINESS ANNALS, NEW YORK, 1926, P. 94.

5. H. H. KIMBALL, "VOLCANIC ERUPTIONS AND SOLAR RADIATION INTENSITIES," MONTHLY WEATHER REVIEW, AUGUST, 1918, P. 356.

periods in which the depression was expected in any event because of the position of the solar curve.

Perhaps a detailed analysis of the economic features of the "rich man's panic" as compared with a clear case of a depression seemingly associated with the solar cycle (1921 or 1932, for example) will solve the question as to whether or not there is a structural difference between both types of business recessions, as some continental economists maintain⁷ and as the solar hypothesis seems to require.

It is worth while to note also that similar occurrences in the past, such as the striking case of the "year without summer" cited above, could be offered as an explanation of the fact—noted by Jevons—that in economic history there are cases of panics which "will not fall into the decennial series."⁸ Jevons stated that this was not inconsistent with his theory, because he admitted the possibility, which no one can deny, of political or other causes as a source of financial panics.

Humphreys has demonstrated that by adding the fluctuations in the pyrheliometric curve (which portrays volcanic disturbances) to the sunspot cycle, a curve can be made which correlates well with the changes of the mean world temperature deviations.⁹ This raises the question again whether the correlations obtained with business curves are only a consequence of a connection through temperature, and whether the "missing link" (tho it cannot be through weather and crops) might be of some indirect kind.

We investigated the point and found:

(1) In temperature fluctuations for the whole world, the volcanic dust factor is the most important one. The small deviations above normal seem to be related to periods of sunspot minima, but all the sharp drops in temperature are clearly related to volcanic eruptions. This is even more clear in the curve of the temperature in the Eastern United States which shows for the period 1880-1913 only the four drops corresponding to the four big eruptions detailed above.¹ On the contrary, in the business curve, as we have seen, the solar cycle is the main factor, and the volcanic dust disturbance a secondary one.

(2) Graphic correlations showed that the connection between temperature and business curves was very small in comparison with the high correlation obtained between solar and economic curves. Progressive smoothing made the correlations grow smaller and disappear instead of making them increase as was the case in the solar business comparisons, thus showing that the main cyclical factors were different in both curves, which

agrees with the findings of the preceding paragraph.

(3) The solar factor in the world temperature curve is the curve of the total amount of sunspots, while in the business curve it seems to be the increase or decrease of sunspots, as shown.

Therefore, in the light of these results, the suggestion of an indirect connection was discarded and the hypothesis of a direct one investigated.

In working out this hypothesis, the comparison of business fluctuations of less than a year with similar series of solar phenomena was made.

For the period since 1920 there is available a good index of solar radiation based on records kept by the Smithsonian Institution's Observatories, which are located in different parts of the world² in order to obtain a true average. The Smithsonian Institution also has published since 1920 mean values of the "preferred-solar-constant." These values are given in calories per square centimeter per minute, the normal value being around 1.940 calories but fluctuating continuously. Dr. Abbot believes that the variation of monthly mean values of the radiation of the sun is really a combination of a small number of regular periodicities, as shown in a chart in which the solar-radiation curve is reproduced by seven curves (not sine curves) of 68, 45, 25, 21, 11, 8 and 6 2/3 months.³

Chart X

To eliminate the influence of seasonal variation,⁴ it appeared to be the best procedure to construct a 12-month moving average of the "preferred-solar-constant" for the period 1920-32.⁵ When plotted as deviations from the normal value, the curve showed plainly not only the 11-year type of fluctuation but also a clear and predominant fluctuation, with waves inside of it forming three well-defined cycles with lengths of 46, 33 and 47 months respectively. When compared with one of the best known indexes of business activity in the United States—that of Col. L. P. Ayres—the same mathematical procedure was followed (12-month moving average) in order to make the comparison possible. The result was strikingly high inverse correlation. A correlation was expected in the main feature (i.e. in the 11-year fluctuation), but the agreement of the three small cycles with similar ones in the business curve was unexpected. The result can be seen in Chart X, in which the solar-radiation curve is plotted upside down to help visualize the inverse correlation. A coefficient of correlation, if calculated, will show a high value, but it was not

2. IN ARIZONA, SOUTH AFRICA AND NORTHERN CHILE.

3. SEE THE LAST ONE, "FORECAST OF SOLAR VARIATION," BY C. G. ABBOT, WASHINGTON, 1933 (SMITHSONIAN MISC. COLLECTIONS, VOL. 89, NO. 5).

4. ANNALS OF THE ASTROPHYSICAL OBSERVATORY OF THE SMITHSONIAN INSTITUTION, VOL. V, C. G. ABBOT AND OTHERS, WASHINGTON, 1932, P. 252.

5. DATA FOR THE SAME, ANNALS . . . , P. 278; DATA FOR 1931-33 OBTAINED BY COURTESY OF DR. ABBOT.

7. SEE M. BOUNTIATIAN, LES CRISES INDUSTRIELLES, PARIS, 1922, P. 44.

8. INVESTIGATIONS . . . , LOC. CIT., P. 233.

9. HUMPHREYS, OP. CIT., P. 590.

1. IDEM, P. 312.

calculated because, according to Dr. Abbot,⁶ the solar values prior to 1926 are not strictly comparable, not so good as those taken after that date. For this reason, the different shape of the first solar-radiation cycle (1921-24) as compared with the following cycles perhaps should not be considered as a real variation of the amplitude of the waves.

Another comparison between business and solar data was made employing an index computed since August, 1924, by the Mount Wilson Observatory. This is an index of a part of the solar spectrum, the ultraviolet rays, which, it will be remembered, vary within a much wider range than the total solar radiation curve. This index was reduced to a 12-month moving average to make it comparable with the rest of the chart.⁷ Altho the period is so short that nothing statistical can be deduced, the existence of a direct correlation is shown.

Let us now take up, therefore, the concluding portion of our investigation in its present stage and note what light it throws upon the relation between human psychology and the business cycle. The psychological theory of the cycle, as we have

seen above, explained it by the appearance of alternating waves of optimism and pessimism, which, coming one after the other, operate to determine the turning points in business conditions. It is precisely this transition from optimism to pessimism which in the speculative community is referred to as "the passing from a bull to a bear psychology."

The last depression affords an almost perfect example of a condition described in these terms. The movement of stock prices during the past few years can be said to represent one of the best indices we have of the state of public psychology, and of the dating of its turning points. Prior to 1925, the number of persons speculating in the stock market was comparatively few, if the number of shares traded can be taken as a fair criterion. After the end of 1924, the increase in the number of stockholders and in the volume of transactions on the New York Stock Exchange was prodigious, the latter increasing from around 200,000,000 shares a year in 1925 to over one billion shares in 1929.⁸

The bursting of this speculative bubble at the end of 1929 affords an excellent opportunity for something analogous to an experiment on the correlation of turning points in solar and speculative activity. Stock prices had experienced an extraordinary rise from a level of around 100 in 1924 to approximately 320 in the first half of 1929, according to the Dow-Jones average of 30

6. IDEM. P. 255.

7. THE MONTHLY DATA WERE TAKEN FROM THE "BULLETIN FOR CHARACTER FIGURES OF SOLAR PHENOMENA," OF THE INTERNATIONAL ASTRONOMICAL UNION. THE NECESSITY OF THE 12-MONTH MOVING AVERAGE WAS CONFIRMED BY THE EXISTENCE OF A CLEAR SEASONAL VARIATION, BECAUSE WHEN THE ORIGINAL DATA WERE ARRANGED AS PERCENTAGES OF THE 12-MONTH MOVING AVERAGE VALUES AND THE MONTHLY AVERAGES FOR THE WHOLE PERIOD WERE TAKEN, IT SHOWED A CLEAR TYPE OF SEASONAL FLUCTUATION WITH A MINIMUM OF 94.2 IN AUGUST, AGAINST A MAXIMUM OF 107.2 IN JANUARY. THE EXISTENCE OF THIS FLUCTUATION WAS SUGGESTED TO US BY DR. ABBOT.

8. FOR THE DETAILS OF THE NUMBER OF STOCKHOLDERS AND THE VOLUME OF TRANSACTIONS THEN MADE, THE READER IS REFERRED TO THE STUDY OF STOCK MARKETS BY THE TWENTIETH CENTURY FUND, A SUMMARY OF WHICH IS ENTITLED STOCK MARKET CONTROL.

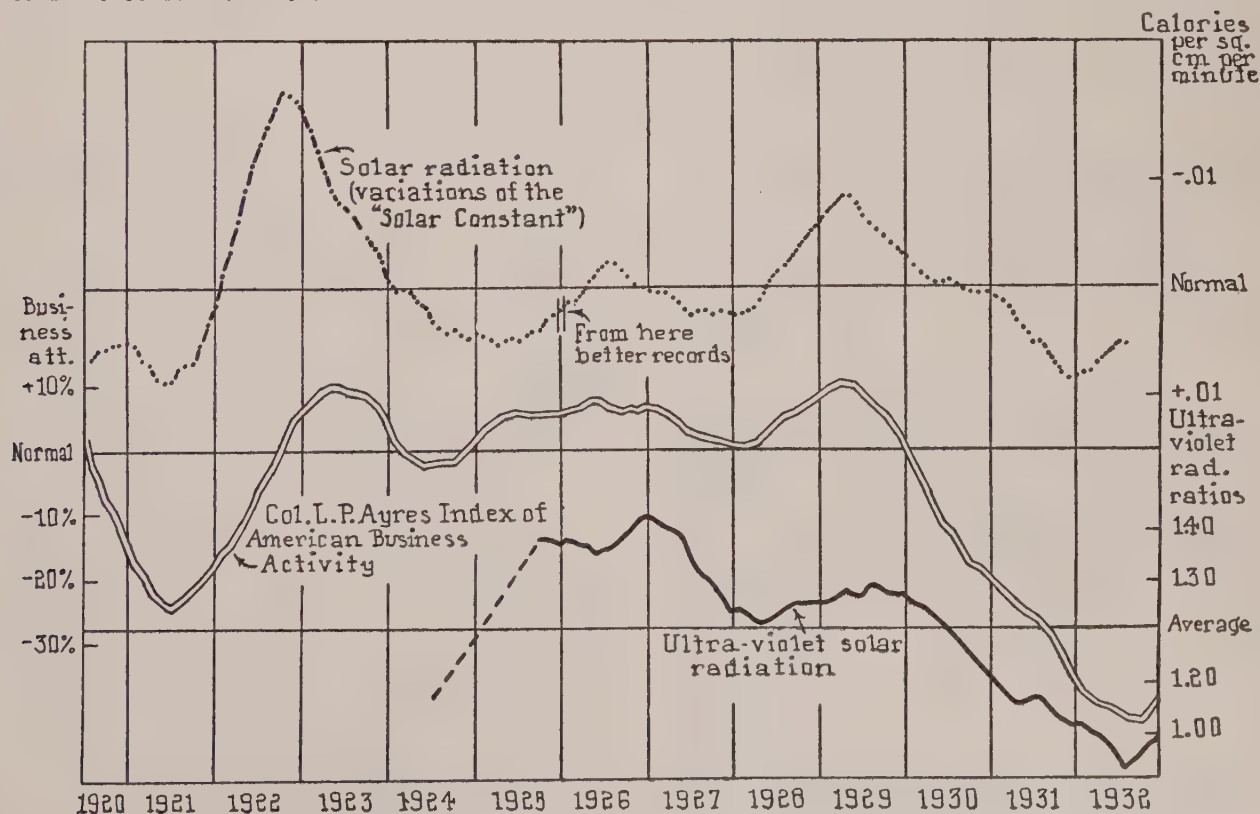


CHART X

industrial stocks. The possibility of a serious break in stock prices was repeatedly broached by financial commentators and by the Federal Reserve Board. Notwithstanding these facts, however, after a vacillation of six months the market began a new rise, and in June, July and August of 1929 the Dow-Jones index added 60 points, increasing to a level of 380 in the early part of September. Then suddenly, and with increasing momentum, speculators, seized with panic, proceeded to dump their holdings. How the whole structure went to pieces in two months is sufficiently well known. We may stress the point here, however, that the piling up of a new layer of optimism upon the top of a prolonged rise of stock prices, notwithstanding all the warnings, and the sudden change from unbounded optimism to frantic pessimism are extremely difficult to explain.

Chart XI

With this in mind, we compared monthly data of speculation in 1929 with variations in solar phenomena for the same year. Based on the results of the preceding pages the monthly measurements of the "solar constant" seem the best solar data with which to begin. For an index of American speculative sentiment, we chose Professor W. L. Crum's index of industrial stock prices, known as "Barron's Averages," because they "are constructed to portray the speculative movement of stock prices rather than the trend of investment prices."⁹ The Barron's Averages were converted to monthly figures to make them comparable with the "solar constant preferred values" because the latter cannot be reduced to a weekly basis. The two curves are shown in Chart XI. The solar-constant values are inverted in accordance with the general inverse correlation which preceding pages revealed to be the case. A glance at the chart will show a striking similarity in the data of the turning points. Furthermore, contrary to expectations, the behavior of the two curves during the whole

year is similar. The solar constant, after remaining on a level far above normal value during the first half of the year, reached a value farthest away from normal, and then came sharply back to normal in November and December. This sharp three-month movement, amounting to 0.013 calories per square centimeter, is the greatest three-month movement in the solar-constant since 1926.¹

When a coefficient of correlation for the two curves was calculated, it yielded a value of $-.886$, a very high value when it is considered that -1.00 would mean perfect inverse correlation.

Because of the fact that the London Stock Market in 1929 made its turning point at the same time as the New York Market, the monthly values of an index of London common stock prices (the "Banker's Magazine" Index) were compared with the solar curve, and the result was an even higher correlation. These data are also shown in Chart XI. The coefficients of correlation between the three curves are as follows:

London and New York stock prices	$+.919$	$\pm .029$
Solar radiation		
and New York stock prices	$-.886$	$+.042$
Solar radiation		
and London stock prices	$-.909$	$.034$

Looking for the reasons for the sharp movement in the solar constant values in September and December, 1929, we found that there was actually an upheaval in the sun, according to all the records available. The mean daily areas, computed by the Greenwich Observatory for periods of 27 days (in order to cover a whole solar rotation),² give the fewest number of spots in 1929 in the solar rotation No. 1016, between August 28 and September 24, with a mean daily area of spots of 273 millionths of the sun's hemisphere; and in the following rotations the solar spots increased tenfold, reaching the maximum figure of 3082 millionths of the solar hemisphere in rotation No. 1019, between November 18 and December 15. A similar action is apparent in the records of the solar faculae. From the figures of the International Astronomical Union, which has detailed daily records for studies of solar-terrestrial relationships of the spots in the central zone of the sun, we find that in this zone (which is just in front of the earth) there were very few spots during September, 1929, there being some days when no spots at all were recorded. In the following month, this zone was covered with spots. Thus, the difference between the September mean figure and that of December was the greatest three-month change in spottedness recorded in the central zone since 1917,³ when the measurements were begun.

9. "THE DOW-JONES AVERAGES AND THE BARRON'S AVERAGES," PUBLISHED BY BARRON'S, NEW YORK, 1932, P. 116.

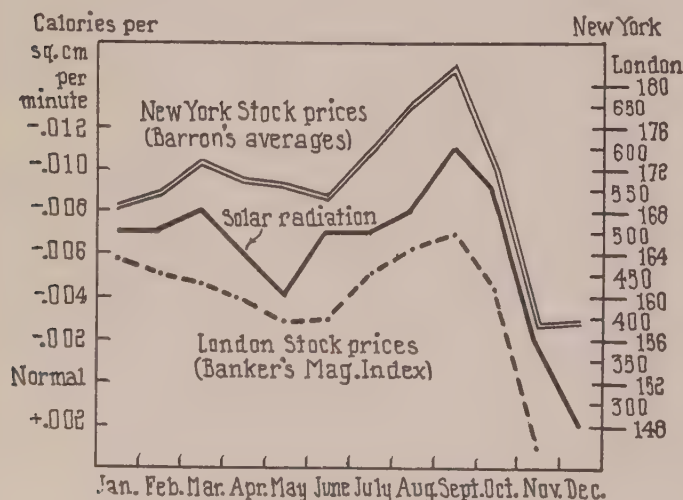


CHART XI

1. THE COMPARISON CANNOT BE MADE FROM PERIODS FURTHER BACK BECAUSE THE PREVIOUS VALUES ARE NOT STRICTLY COMPARABLE IN AMPLITUDE, AS HAS ALREADY BEEN EXPLAINED.

2. TAKEN FROM MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY, VOL. XC, P. 303.

3. BULLETIN FOR CHARACTER FIGURES OF SOLAR PHENOMENA, ZURICH. SEE OCTOBER-DECEMBER, 1929, AND PREVIOUS NUMBERS.

We have emphasized this change in the spottedness, having in mind the quotation of Bauer cited earlier in this paper, to the effect that this is the most important from a terrestrial point of view.

Let us now direct attention to the opposite side of the picture, and consider the turning point from depression to the beginning of a rise in its relation to the curve of solar activity. In particular, let us consider the question why the revival in stock prices which took place in the first quarter of 1932 did not continue, but instead was followed by a sharp drop which did not reverse itself until July of that year. Solar-constant values exactly comparable to those we have used for 1929 are not available because the observations of the Chilean Station, the most important one of the Smithsonian Institution, were discontinued in April, 1932, on account of the eruption in the Andes. But the sunspot records show clearly a phenomenon, the inverse of that of 1929. The Greenwich measurements of sunspot areas show that the higher values of 1932 were reached in the rotations No. 1052 and 1053, from May 6 until July 27, with 367 and 363 millionths of the sun's visible disc covered with spots. Then the solar surface became cleared, and three rotations later the average went down to only 15 millionths of the sun's disc (rotation No. 1057, from September 19 until October 16).

The same thing can be said about the Greenwich figures of area of solar faculae.

Chart XII

This fact is even clearer in the Relative Sunspots Numbers for the central circle zone, of which monthly data are available, and they have

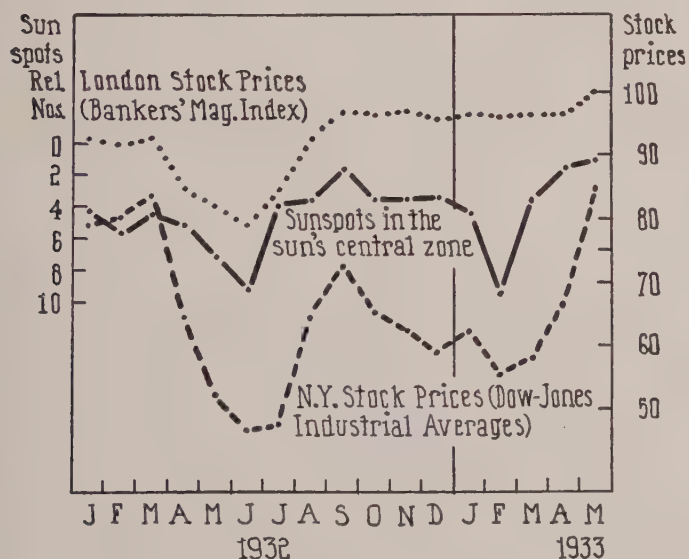


CHART XII

the advantage of representing not all the solar surface but only the central zone that affects the earth most.⁴ See Chart XII.

It is known that the lowest prices for common stocks in the New York and London Stock Exchanges were reached in the first half of July, 1932, as can be seen from Chart XII, in which New York stock prices are pictured by the "Dow-Jones" average of industrial stocks,⁵ and the London prices by the Banker's Magazine Index. The graph shows the curious fact that the recession in the last quarter of 1932 is also visible in the solar curve. And it is interesting to note that the solar curve, as shown on Chart XII, makes a second low in February, 1933, turning up again in the following months. Altho this is a fact, too much should not be expected of comparisons for the year 1933 because, except for clear solar changes which are sudden and which can be associated with the turning points, it is too much to hope for an exact month-to-month correlation. In the years in which the speculative curves moved steadily up or down, such as in 1930-31 and previous to 1929, no clear month-to-month relation has been found between solar and speculative short swings, except for the seasonal movements of the speculative curve in the down swing, which perhaps can be associated with the similar seasonal variations of the solar-terrestrial physical curves such as magnetic activity and aurora borealis.

By way of conclusion, we wish to repeat that the results of this paper are not supposed to be in any sense final. The results are so striking, however, that it is thought desirable to publish them in their present preliminary stage in the hope that other investigators may be encouraged to do further work along the same lines and contribute suggestions and criticisms. In particular, it should be noted that the aspect of this subject which requires the most careful attention is that which concerns the direct effect of various manifestations of solar activity upon the psychological attitudes of human beings. The value of the high correlations obtained depends upon the proof of the validity of a direct causal relation between solar and human activity.

Carlos Garcia-Mata.

The Argentine Embassy, Washington, D. C.

Felix I. Shaffner.

Harvard University.

4. BULLETIN FOR CHARACTER FIGURES . . . , NOS. OF 1932 AND 1933. ZURICH.

5. WE COULD NOT USE THE SAME INDEX AS IN THE PREVIOUS CHART BECAUSE IT HAS BEEN DISCONTINUED. THE INDEX USED WAS TAKEN FROM THE DOW-JONES DAILY AVERAGES, NEW YORK, 1934.

Letters to the Editor

SHORT CYCLES IN STOCK PRICES

Dear Mr. Dewey:

I read your article on the 17-week cycle in the July issue of *Cycles* with great interest. I found it most informative and satisfying because I have been playing with short cycles in the stock market. However, I used one particular stock instead of the Industrial Stock Price Index.

I used 160 weekly averages starting with the week of October 25, 1954. I found a real cycle (at least it seems real to me) of 16 weeks. To date, there have been nine repetitions of this cycle. The highs occurred five times on time. Twice the actual high came four weeks late. Once it came two weeks early and once four weeks early. The results with the lows were about the same.

My 16-week cycle has about the same amplitude as your 17-week cycle.

Perhaps I may be wrong as I did not refine the work too much as yet. My technique was as follows: I took a 17-week moving average of the logs and used the deviations. These I put into a 16-week periodic table. Each half of the table was smoothed with a 5-week moving average. I have not as yet used any refinements such as the elimination of randoms. Perhaps my cycle may change when I try to refine it.

I tried a 17-week periodic table, but my results were not good.

I would greatly appreciate your informing me of the techniques which you used in your 17-week cycle work. Perhaps I can refine my work.

Sincerely,
S. M. Goldstein

Our Reply

Dear Mr. Goldstein:

It may be wiser for the individual to work with the particular stocks he is interested in. Even if you develop a good analysis of the general market you would still not know about single issues.

Of course we are using the Standard & Poor's Industrial Stock Price Index for our work, and will continue to use it.

The fact that we use an average does introduce the possibility of variations between the results we get, and the conclusions of individual members of the Foundation who are working with individual stocks.

We are working with short cycles in weekly figures because it gives us so many more repetitions of any cycles we might find that perhaps we can develop a better understanding of how cycles work.

In the area of short cycles in the stock market the fundamental scientific interest of the Foundation (are cycles present, how do they work?) and the cultural interest of our members (including the search for the bucket of gold) dovetail neatly.

But you must remember that there are 425 stock

issues in the Index we are using. As our study progresses it should develop into a fair short-term analysis of the general market. But the results will not necessarily apply to any single stock. Many of these will show no evidence of a given wave length. Others will have some of the waves we find, but not others.

You mention the amplitude, but not the timing of the 16-week cycle you found. If a wave is present in the average Index, and also in an individual issue, the timing probably should be much the same. Do not assume from this that our 17 and your 16 are the same cycle. You should stick to the facts as you find them in your series. However, if your timing is the same as ours, it may eventually turn out to be the 17-week cycle. If the timing is the same, keep it as is, but watch it closely for a possible revision to 17 weeks. It may be that the addition of more data will modify your conclusions.

We started with a ten year period which gave us 30 repetitions of the cycle.

What we have done so far with these figures is quite a story, but here is a brief summary:

We started with the weekly figures for the 1948-1958 period, and

a. Computed a 17-week moving average of the logs of the data, and the deviations from it.

b. Made a 17-week time chart of the deviations. This time chart indicated possible lengths of 17, 17 $\frac{1}{2}$, and 15 $\frac{2}{3}$ weeks. A 15 $\frac{2}{3}$ week time chart indicated a length of 16.2 weeks.

c. A 16.2-week periodic table of the deviations indicated a length of 16.8 weeks.

d. A 16.8-week table indicated a length of 17.3 weeks.

e. A 17.3-week table indicated 17 weeks.

f. A 17-week table did not slip. We used 17 as the average length in this period and definitized the cycle.

At this point the result was reported in the July issue of *Cycles*.

There were other computations which are not listed above. For instance, we made a 3 line moving median of the 17-week periodic table and plotted the result. The 17-week cycle was more apparent because of this averaging.

Then we added the ten previous years to the data. The same deviations were computed and put into a 17-week periodic table. This addition gave us 30 more repetitions of the cycle.

We used the later period as the second half, and the earlier period as the first half of a new, longer table. When these two halves were compared, a slightly longer length (17.15 weeks) was indicated.

A 17.15-week table of the entire 1938-1958 period indicated a length of 17.08 weeks.

At this point we had a slightly modified length.

This was mentioned in the next issue of *Cycles*. However, we did not report in full because we wished to add still more data, and to try other techniques.

Next we computed a 5-week moving average of the logs of the data and then the 5/17-week deviations. We filtered these deviations for a possible 17-week cycle by using the formula:

$$C - 1/2(17B + 17A)$$

This is one of W. C. Yeatman's formulae. This particular formula doubles any 17 cycle present, and also any 8 1/2 cycle present. At the same time it completely removes any 34 cycle and any 11 1/3 cycle. (We had earlier had hints of the lengths we removed.)

The filtered deviations were plotted and a 17-week time chart drawn. The time chart indicated a length of 17.08 weeks.

Now we are adding the weekly figures back to 1926, and will continue the analysis using these additional figures.

We plan to report on this work in the October issue, and to have the situation clarified before we move on to the next cycle.

Yours truly,

REPORT DATE

Dear Sir:

I notice that a recent report was called "May-June." I thought you published 12 reports a year? Won't this make merely 11 for 1958? How come?

Very Truly,
R. M. C.

In Reply

Dear Sir:

The May-June report was merely a strategem to advance the publication date. In April you got the April report. In May you got the May-June report. In June you got the July report, etc.

Twelve reports will be issued in 1958, only the one you get late in December will be called January 1959 instead of December 1958, as last year.

Cordially,

HUMAN CYCLES

Dear Mr. Dewey:

The difficulties with cycles cited by R. J. L. in the April 1958 issue of *Cycles* are quite real. Your systems err because there is no way of separating the effect of the natural cycles from the human or psychological cycles. An example of natural cycles are sunspots and the weather. A human cycle is the frequency of wars. Both the weather and war effect the business cycle; yet I am not aware that you used, or could use, the war cycle in formulating your stock market projection to 1990.

It can be argued that since your synthesis is based on past performance of stock prices the effect of war is included in your forecast. . .

Again, the value of money or inflation is strictly a human cycle. A very curious one, because while it is of humanity it never has been really under human control. . . . The history of the ever present cheapening of money in all times and climes makes the most dreary reading in which it is possible to indulge.

The human cycles are really imponderables. They only seem not to be because they are measurable...

A dictator could wake up with a hangover and order atom bombs dispatched at a fancied enemy. You have a major war not predicted by the cycle. Unscrupulous national leaders could have the printing presses started and flood the nation with very cheap money. You have confiscatory inflation, immediately, and a gross departure from the cyclic creeping inflation.

In my opinion your stock market projection is weighted too much with natural cycle effects and not enough with the human. I certainly regret I have no suggestions as to how you can remedy this situation.

Sincerely yours,
Morris Dickason

Oak Park, Illinois

Our Reply

Dear Mr. Dickason:

I make no distinction between natural science cycles and social science cycles. I believe that social science cycles are caused by natural science cycles, the nature of which are as yet obscure.

For example: it seems to me probable that the 22-year cycle of international battles is the result of some perfectly natural 22-year environmental force, something like the 12-month seasonal cycle, that tends to make us human beings more warlike in alternate 11-year periods; just as the weather is colder in alternate 6 month periods.

Of course, a dictator with a hang over could disrupt the cycle and doubtless many of them have, but on the average, I think they are more likely to go haywire in the 11-year positive portion of the cycle than in the 11-year negative portion of the cycle.

I do not use war cycles to throw light on stock market behavior, but you will notice that a 22-year cycle is inherent in stock prices; just as it is in international war. I do not believe that this is the result of war. I think that the human beings who buy and sell stock are influenced by the same natural environmental force that influences the human beings that make war. Only, you will notice, as seems to be true in all instances, that the cycle in economic affairs is upside down in relation to the cycle in battles.

As far as I know there is no cycle of inflation. It is continuously upward. However, one of our members has told me that his studies show that devaluation in England for the past 800 years has recurred at about 54 year intervals. I myself have never studied this matter.

Ever cordially yours,
Director

Foundation Affairs

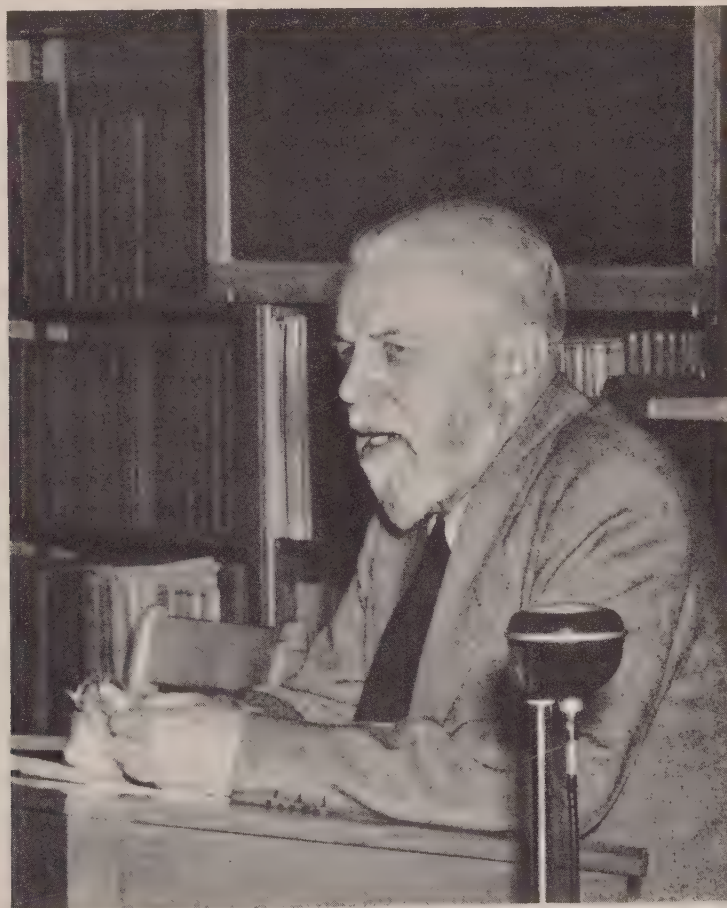
PROFESSOR KROEBER ELECTED TO COMMITTEE

It is a pleasure to announce that our Board of Fellows, at their meeting on July 24th 1958, elected Professor Alfred L. Kroeber to membership on the Committee of the Foundation.

Who's Who in America lists the following facts in regard to Professor Kroeber:

KROEBER, Alfred L., anthropologist; b. Hoboken, N. J., June 11, 1876; s. Florence and Johanna (Mueller) K.; A. B., Columbia U., 1896, A. M., 1897, Ph.D., 1901, Sc.D. Yale, 1946; LL.D., California, 1951; D.H.L. (honorary), Harvard University, 1952, Columbia, 1953; married Henriette Rothschild, May 24, 1906 (dec.); m. 2d Theodora Kracaw Brown, Mar. 26, 1926; children—Clifton, Theodore (stepsons), Karl, Ursula. Asst. in English, 1897-99, fellow in anthropology, 1899-1900, Columbia U., anthropological expedns., 1899-1901, New Mexico, 1915-20, Mexico, 1924, 30, Peru, 1925, 26, 42; instr. anthropology, 1901, asst. prof. 1906, asso. prof., 1911, prof. 1919-46,

curator, 1908-25, dir., 1925-46, Anthropol. Museum, U. of Calif. Ethnol. exploration in Calif. since 1900; curator anthropology, 1900, and 1903-11, Calif. Acad. Sciences; research asso. Chgo. Natural History Museum., 1925- ; vis. prof. Harvard, 1947-48, Columbia, 1948-52, Brandeis, 1954, fellow Center for the Advanced Studies of Behavior Science, 1955-56. Founder and president, 1917, Am. Anthropol. Assn.; pres. Am. Folk Lore Society, 1906. Mem. Linguistic Soc. of America (pres. 1940), Nat. Acad. Sciences, Am. Philos. Soc., Am. Academy Arts and Sciences, American Ethnological Society. Recipient of the Huxley Medal, Royal Anthropological Institute, 1945; Viking Medal, 1946. Author: Zuni Kin and Clan; Peoples of the Philippines; Anthropology 1923, 1948; Handbook of Indians of Calif Cultural and Natural Areas; Peruvian Archaeology; Configurations of Culture Growth; The Nature of Culture; Style and Civilization, 1957. Address; Univ. of Calif., Berkeley 4, Calif.



Alfred L. Kroeber

Chapter Affairs

KANSAS CITY

A Kansas City Chapter is being organized by J. H. Bruening as Temporary Chairman. Members of the Foundation who live in the Kansas

City area can expect to hear from Mr. Bruening about the first meeting. It is expected that an early fall meeting will be organized.

SAN FRANCISCO

The San Francisco Chapter held a meeting on July 16 at which twenty-four persons were present. An interesting floor discussion about the various members' interest in cycles was held.

The chapter extends a cordial invitation to all Foundation members to join.

The officers of the Chapter are:
Irving L. Fisk, 41 Sutter Street.
Richard A. Hanan, Mills Tower.
Mrs. Maxine Taylor, 655 Sutter Street
Lionel Whitnah, 33 Canvon Road, Berkeley.

WASHINGTON, D. C.

The July meeting of the Washington Chapter was held July 25 at the Washington Post Building, 1515 L Street, N.W.

All members who missed this meeting, but would like to attend in the future should contact Ralph

C. Benner, Temporary President at Jackson 7-2148, or A. Sherwood Vickers, Temporary Secretary, at National 8-8387.

E. R. Dewey will address the Washington Chapter on Wednesday, October 29, at 8:00 p. m.

NEW YORK

The regular monthly dinner-meeting of the New York Chapter was held on June 17 at the White Turkey Town House in New York City. It was the best attended Chapter meeting to date. One hundred thirty-four Members and their guests were present. Among the honored guests on the dais was the Grand Marshall of the International Order of St. Hubert, Mr. Albert F. Messany of Vienna, Austria.

The social hour preceding dinner was highlighted by the distribution of the first issue of the official publication of the New York Chapter, *Cycles Briefs*, containing eight pages of news and pictures about Chapter activities.

The featured speaker of the evening was E.R. Dewey, Director, Foundation for the Study of Cycles. His presentation was in three-parts:

- 1) Cycles in War
- 2) Results of Recent Research on Short Cycles in the Stock Market
- 3) Question and Answer Period

Perhaps the best known rhythmic cycles in international battles, Dewey stated, are the 22-year cycle and the 11-year cycle.

Dewey also referred in his address to other prominent cycles in international battles, namely those 57 years long and 142 years long. The composite wave formed by these latter two cycles and the former two is now clearly on the way up, with

a peak for the composite wave to be reached ideally sometime during the early 1960's.

During the second portion of his talk, Mr. Dewey discussed the results of recent research which the Foundation has been conducting on short-term cycles in the stock market.

Mr. Dewey reported that the Foundation's recent work with stock market data has confirmed the presence of what appears to be a cycle about seventeen weeks long. Weekly figures going back to the beginning of 1948 were used.

Our June dinner-meeting was fittingly climaxed by a question-and-answer period conducted by Mr. Dewey. It lasted over two hours and featured the capable handling of countless cycle queries on the part of the Foundation Director.

The following meetings have been scheduled by the New York Chapter for the coming months.

On Tuesday, August 12, Leonard H. Lempert, Director of Statistical Indicator Associates, will address the New York Chapter on the subject "Recognizing Cycles in Contemporary Business Statistics."

On Wednesday, September 10 John Nelson, of the Radio Corporation of America will speak on "Planetary Arrangements and Their Effects on Radio Transmission."

On Tuesday, October 14, Dr. William Dement of the Mt. Sinai Hospital will talk on "Rhythmic Cycles in Dreams."

Jack A. Dorland

The Cycle Round-up

SEPTEMBER 1958

Because of the space required for this month's reprint the Round-Up is limited to a report of the latest figures for the series regularly discussed.

The October issue of *Cycles* will again carry the more complete Round-Up section.

Aluminum Production

Recent monthly production of domestic primary aluminum has been:

1958 - Mar	134.0 thousand tons
Apr	125.0
May	not yet available

The dominant 6.4-year cycle in aluminum production is due to exert a downward pressure until 1959.

Automobile Factory Sales

Recent monthly figures of automobile factory sales are:

1958 - Apr	322 thousand cars
May	352
Jun	not yet available

It is doubtful that second quarter 1958 sales will exceed 1,100 thousand cars. Total factory sales for the second quarter of 1957 were 1,575 thousand cars.

For the details about the four cycles so far isolated in factory sales of automobiles see *Cycles*, January, 1958.

The combination of these cycles is moving sideways at the present time.

Bond Yields

The long 54-year cycle in bond yields is on its way up until 1978. This fact provides underlying strength.

In recent months bond yields have been:

1958 - May	4.00%
Jun	3.98
Jul	3.99p

These figures are for all do-

mestic corporate bonds (Moody's).

Copper Prices

Recently the actual price of electrolytic copper at New York has been:

1958 May	24.30 cents per pound
Jun	24.69r
Jul	not yet available

Corn Prices

The 67-month cycle in corn prices is due to crest in the near future. Prices are then due to go down until 1961.

The recent actual monthly prices of No. 3 yellow corn at Chicago have been:

1958 - May	131 cents per bushel
Jun	135
Jul	135p

Egg Prices

Our analysis of the price of eggs includes two cycles, a 12-month cycle and a 26.5-month cycle.

May and June are low months in the combination of the two cycles. After June the combination turns up toward the peak months of September and October.

The price of eggs, extras, large, wholesale, at Chicago for the past few months has been:

1958 - Apr	38.0 cents per dozen
May	36.0
Jun	35.2

Liabilities

Recent monthly figures for the liabilities of commercial and industrial failures are:

1958 - May	56.2 million dollars
Jun	61.4

The cycles we have so far isolated in this series are exerting an upward pressure at the present time. (Up 44% from last half of 1957.)

Residential Construction

Recent monthly figures of

residential construction contracts awarded have been:

1958 - Mar	1,071 million dollars
Apr	1,240
May	1,346

We have isolated and combined the seasonal pattern and the 32.2-month cycle in this series. The combination shows a 1958 high in April.

Stock Prices

Our analysis of the long cycles in stock prices is based on Standard and Poor's Combined Index of Stock Prices. This Index for recent months has been:

1958 - May	43.70
Jun	44.75
Jul	45.66p

The combination of the 11 long cycles we have isolated in stock prices is downward and introduces a note of caution into the present situation.

Sunspot Numbers

Recent monthly sunspot numbers have been:

1958 - Mar	189
Apr	182p
May	175

Unemployment

The per cent of the total civilian labor force unemployed in recent months has been:

1958 - Apr	7.53%
May	7.11
Jun	7.72

Wheat Prices

Recent monthly prices of No. 1 Dark Northern Spring Wheat at Minneapolis have been:

1958 - Apr	241.7 cents per bushel
May	243.3
Jun	247.3

Geisinger Indicator

BACKGROUND

The Modified Geisinger Indicator is a series of numbers which, in the past, have gone up and down ahead of corresponding movements of the Federal Reserve Board Index of Industrial Production. The Modified Geisinger Indicator thus throws some light on the probabilities of the future.

The F. R. B. Index of Industrial Production measures physical production in the U. S. A. It is a weighted average of tons, yards, gallons, and numbers of things produced each month.

The Modified Geisinger Indicator is the sum of two Indicators, the Geisinger Indicator and a First Difference Indicator.

The Geisinger Indicator was invented by Robert Geisinger. It is derived from figures which are published each month in the *Survey of Current Business*. It is recorded for you in Column 2 of the table which summarizes the forecast.

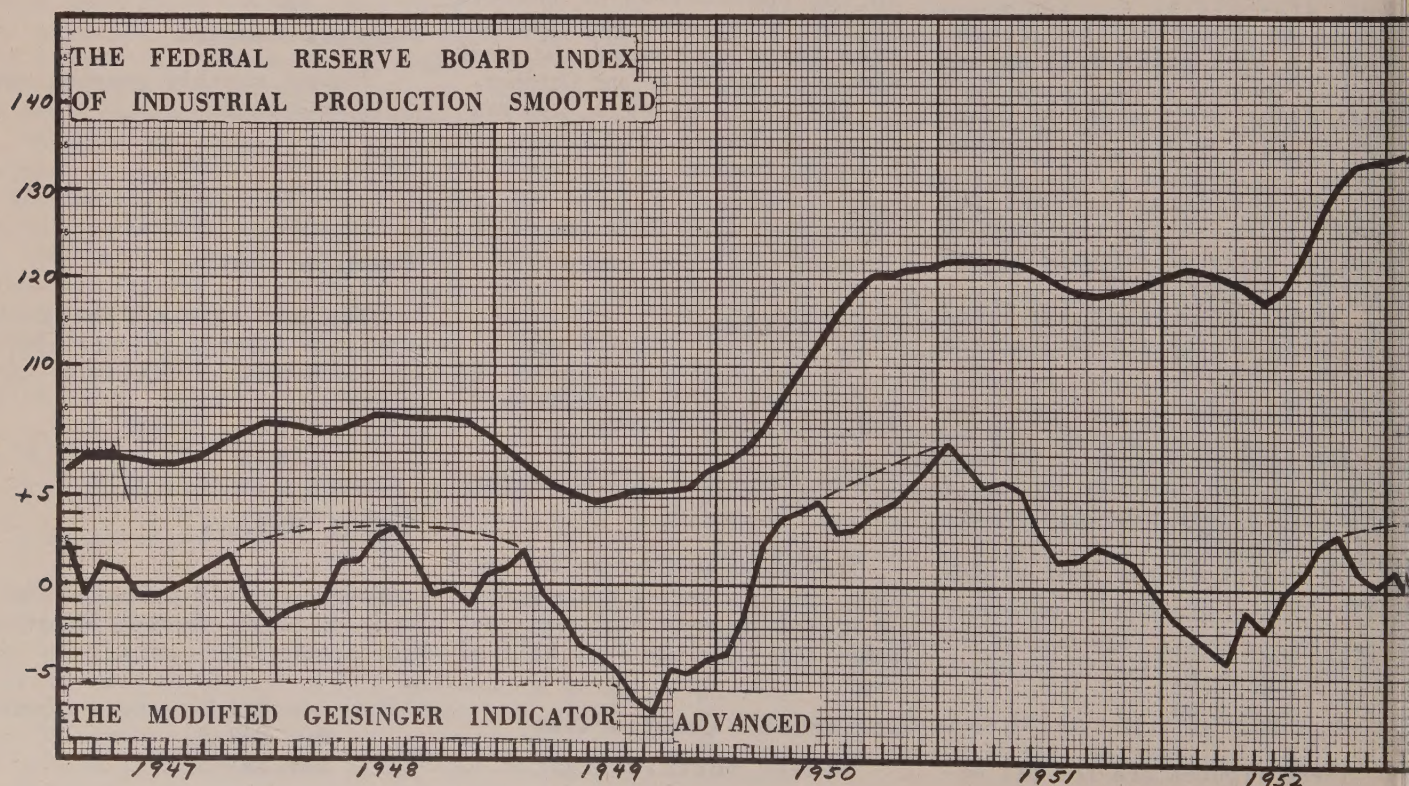
Column 3 of the summary table gives the First Difference Indicator, which is merely the amount by which the smoothed F. R. B. Index is above or below the value for the preceding month. The smoothing is effected by means of a centered 3-month moving average posted to the second position.

Column 4 is the sum of the values in Column 2 and 3. This value is called the Modified Geisinger Indicator. It suggests in a general way what the F. R. B. Index may do some eight months later.

The smoothed values of the F. R. B. Index of Industrial Production are diagrammed below as the top line on the chart. The latest actual monthly Index of Production is recorded by a dot.

The bottom line on the chart gives the Modified Geisinger Indicator (Column 4 of the table) advancing it by eight months. This advance is for two reasons: (1) so that you can more easily compare the past behavior of the Modified Geisinger Indicator with the behavior of the F. R. B. Index and (2) so that you can have a better idea of what the F. R. B. Index may do in the future.

The correspondence between the two lines on the chart is general rather than specific. It is not to be expected that every little wiggle in the Modified Geisinger Indicator is significant. It is rather the broad sweep of the line which is to be watched. The dashed lines which are added show the manner in which the eye should follow the Indicator.



FORECAST

The Federal Reserve Board revised the previously reported Index of Industrial Production for May from 127 to 128. The Index of Production for the month of June is up to 130. June was the second straight month of increase since the April low of 126.

The Geisinger Indicator for March 1958 (November 1958 when projected) is -2.4, up slightly from the previous month.

The First Difference Indicator for April 1958 (December 1958 when projected) is revised upward to -1.50 because of the revision in the Index of Industrial Production. The preliminary value for May is 0.00.

These two indicators are combined to obtain the

Modified Geisinger Indicator. The Modified Indicator for March 1958 (November 1958 when projected) is confirmed at -4.73. The worst possible values that could develop for this indicator (unless published source figures are revised) are -3.9 for April, and -1.4 for May.

The turn in the Modified Indicator confirms that the decline has halted, at least temporarily. It should be pointed out that the First Difference Indicator is largely responsible for the upturn. The recovery in the more sensitive Geisinger Indicator has been much slower. Not until the Geisinger Indicator has reached 2.50 is there any real reason for optimism.

July 24, 1958

E. R. Dewey

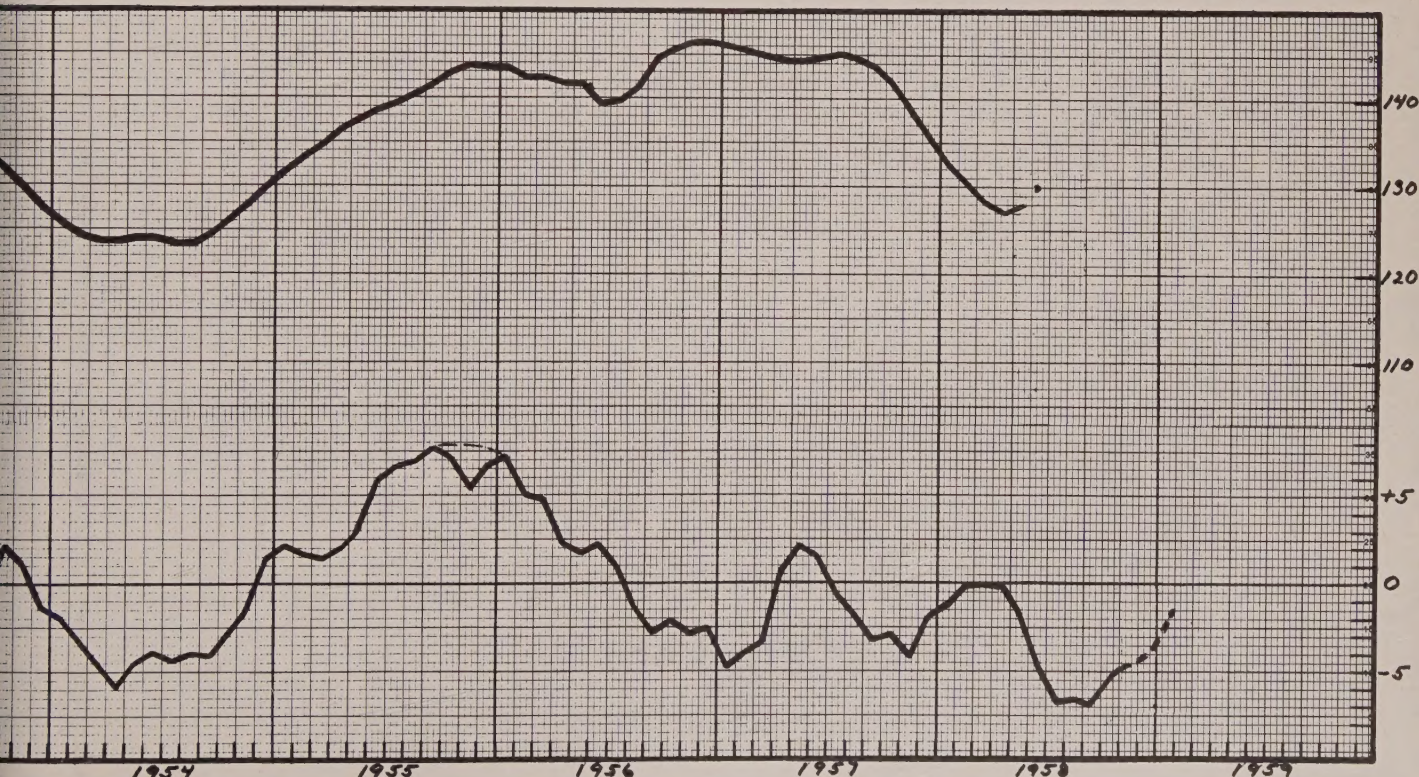
		1	2	3	4		
Month		F.R.B. Index	Geisinger Indicator	First Difference Indicator	Modified Geisinger Indicator	Timing Advanced 8 Months	
Oct.	1957	142	-3.4	-1.50	-4.90	June	1958
Nov.		139	-4.2	-2.50	-6.70	July	1958
Dec.		135	-3.6	-3.00	-6.60	Aug.	1958
Jan.	1958	133	-3.8	-3.00	-6.80	Sept.	1958
Feb.		130	-2.6	-2.66	-5.26	Oct.	1958
Mar.		128	-2.4	-2.33	-4.73	Nov.	1958
Apr.		126	-2.4w	-1.50r	-3.9w	Dec.	1958
May		128r	-1.4w	0.00p	-1.4w	Jan.	1959
June		130p	*	*	*		

p - preliminary

* - not yet available

w - worst possible

r - revised



Mr. H. A. Musham
741 No. Rush St.
Chicago, Ill.

DON'T YOU WANT TO KNOW HOW TO MAKE A CYCLE ANALYSIS?

Edward R. Dewey, our Director, has written 23 lessons telling *How to Make a Cycle Analysis*. These lessons give you the essence of what Mr. Dewey has learned in this field in 20 years of study and work.

These lessons are the ones used in the correspondence course we gave in 1955 and 1956. (The correspondence course as such is no longer being given.)

The lessons start at the beginning and assume that you are a high school graduate with no knowledge of mathematics beyond arithmetic.

Four lessons are devoted to a study of the elementary statistics needed as a prerequisite for cycle study. These lessons are supplemented by parts of a college text book of statistics, also provided.

Nineteen lessons are devoted to the techniques of cycle analysis as such. Most of this material is unavailable from any other source.

The lessons are supplemented by additional comment and material which grew out of questions and mistakes of correspondence course students.

Problems are provided for the student to work, but *no papers will be corrected*. We are *not* offering a correspondence course.

The lessons are mimeographed on $8\frac{1}{2} \times 11$ paper, punched for 3-hole binder. Printed charts are provided. Other printed material is included. There are over 600 pages in all, plus the text book on statistics referred to above.

The price for all the material and the text book is fifty dollars, cash with order.

Free examination for 10 days permitted. If not entirely satisfied you may return within that time for full refund.

Send in your check today and a set of the lessons will be prepared for you.

FOUNDATION FOR THE STUDY OF CYCLES

East Brady, Pennsylvania